CIVIL ENGINEERING

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LIFT-SLAB FRAME FOR FORD'S RIVER ROUGE OFFICE

See article by John P. H. Perry

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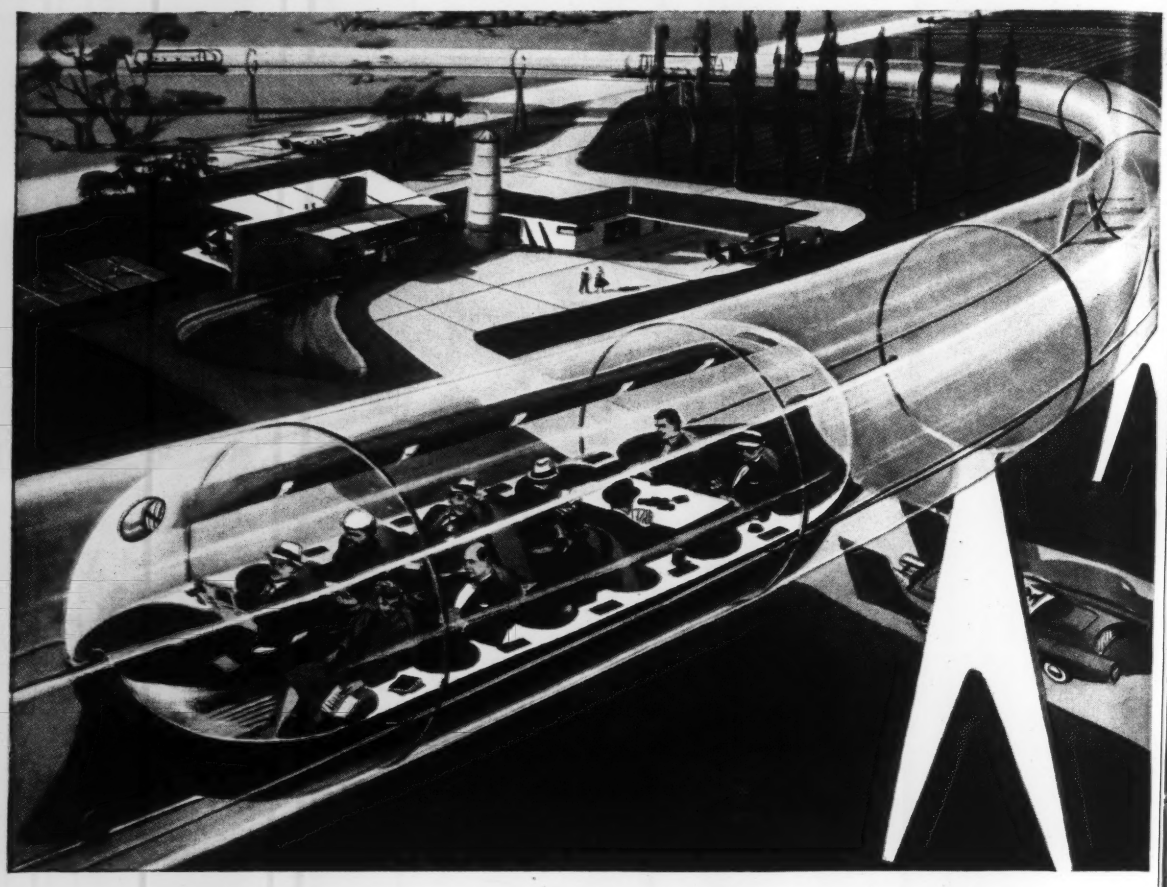

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42,900 copies of this issue printed

CIVIL ENGINEERING

JUNE 1955
VOL. 25 • NO. 6

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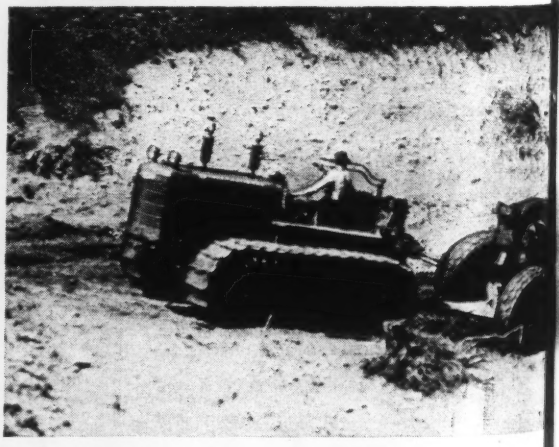
DAM FOR CORDRY LAKE, 700 feet thick at the base, is built by this fleet of three INTERNATIONAL TD-18A crawlers and scrapers and one INTERNATIONAL TD-14A with hydraulic dozer used for push-loading on inclines and in soft spots, and some other equipment.

LAKE LEAKAGE is eliminated by removing all porous soil and stone from the site of the dam base and replacing it with impervious clay fill from distances up to 1,000 feet from a nearby hill.

BUILDING UP THE DAM BASE moves along on schedule as one of three TD-18A scraper combinations brings a heaping load of clay to the construction site.



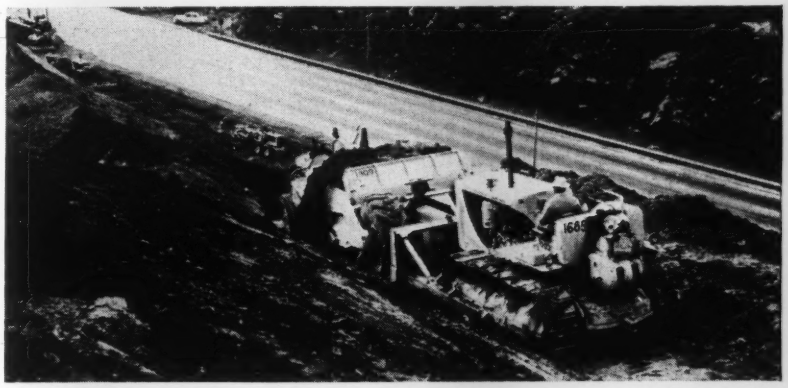
Even with a number of switchbacks, it took the rugged power of Cat DW20 Tractors to negotiate these grades.

The Waldo Grade project has been one of California's most important highway construction jobs during the past year. A serious traffic bottleneck had built up at the northern end of the Golden Gate Bridge, where 25,000 vehicles a day carry commuters from Marin County into and out of San Francisco.

Two new traffic lanes had to be added to Route 101, widening it to six lanes, and a second tunnel had to be driven through the mountain, providing three full lanes for both north and south bound traffic. Accomplishing these objectives involved cutting away a rocky hillside and moving the material—much of it heavy with copper, iron and magnesium ore—down to the fill in a deep ravine alongside the highway. About 1,500,000 cubic yards of earth had to be moved. This part of the contract, amounting to over $4,000,000, was handled by Guy F. Atkinson Company of South San Francisco.

An interesting factor in the job was the kind of grades encountered. "They were like the side of a roof," one observer reported. And the men who operated Atkinson's fleet of CAT* DW20 Tractors and No. 20 Scrapers agreed. The tough machines hauled big loads of fill down a slope that dropped nearly 600 feet in a little over half a mile. And on the return trip, empty, they had to make their way up the same 20 per cent grade.

Eleven of the DW20 wheel rigs were used on this contract. Other CATERPILLAR* equipment included four D8 Tractors for push-loading and bulldozing, two No. 12 Motor Graders to work on the haul roads and a Caterpillar D13000 Diesel Engine powering a Gardner-Denver air compressor. Approximately 80 per cent of the machines on the earthmoving job were Caterpillar-built.



A D8 with No. 8S Bulldozer push-loads one of the scraper units on Waldo Grade.

Many successful contractors have found it pays to standardize on the big yellow machines. Service and maintenance are simplified, many parts are interchangeable, and operators are familiar with the equipment. Caterpillar dependability, freedom from down time and long work life are clinching arguments for standardization.

A No. 12 Motor Grader levels fill and works on haul roads.

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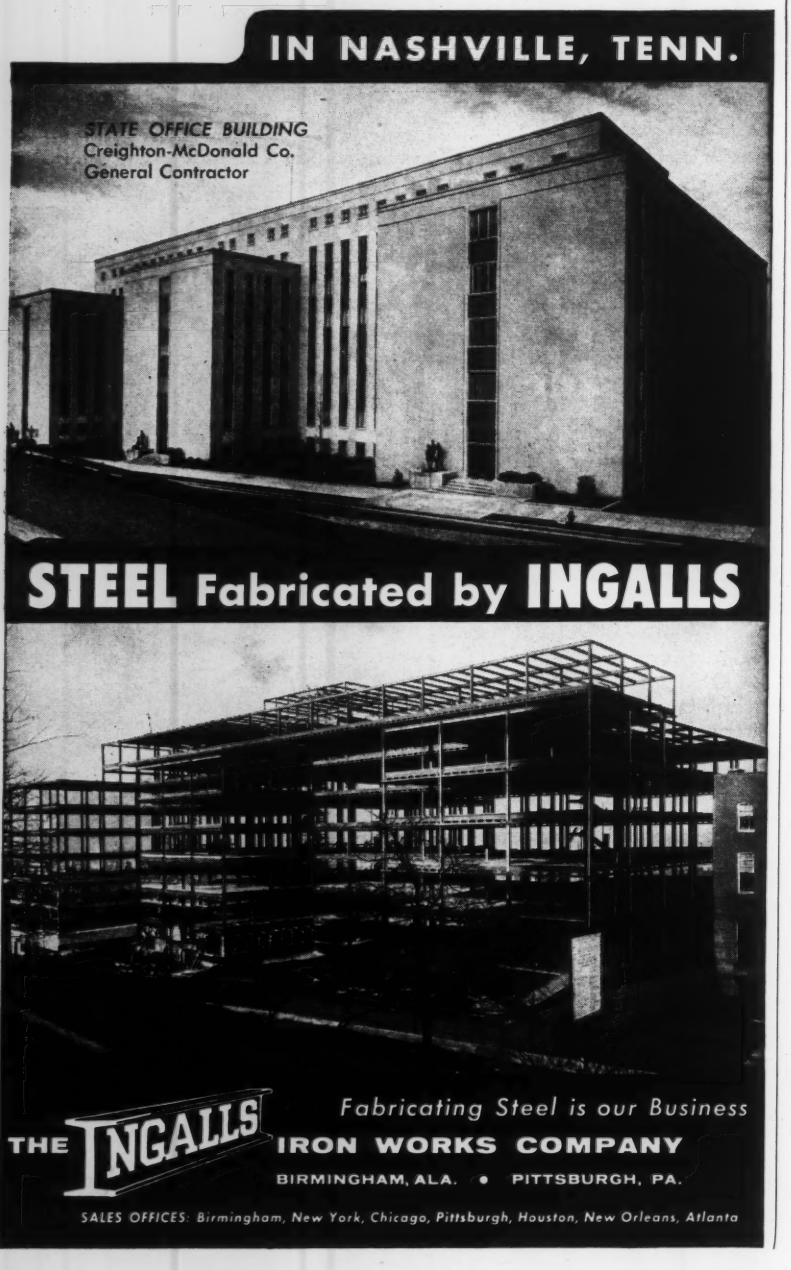
NEWS OF ENGINEERS

James W. Daily has been promoted to full professor and **John M. Biggs** to associate professor in the civil engineering department at Massachusetts Institute of Technology. The promotions will be effective July 1.

Richard Hazen and **Alfred W. Sawyer,** Engineers, announce the removal of their offices from 110 to 122 East 42nd Street, New York 17, N.Y.

Octavio Marcondes Ferraz has been nominated by the president of Brazil to the post of Minister of Transportation and Public Works. As technical director of the Cia. Hidro Electrica do Sao Francisco, Mr. Marcondes Ferraz recently completed the first phase of the Paulo Afonso Power Plant project, one of three underground powerhouses that will utilize the waters of the Sao Francisco River. He is one of the country's outstanding engineers and a member of the Brazil Section.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George P. Rackle

George P. Rackle has been elected president of the George Rackle & Sons Co., of Cleveland, Ohio, and Houston, Tex. Mr. Rackle succeeds his father, George L. Rackle, who was named chairman of the board. The Rackle firm, founded in 1870, is one of the nation's oldest and largest manufacturers of precast concrete structural products.

Charles E. Carver, Jr., formerly a research engineer at the Massachusetts Institute of Technology Hydrodynamics Laboratory, received the degree of doctor of science in civil engineering from M.I.T. this February. Dr. Carver is currently employed as a senior engineer in the hydrodynamics section of the Glenn L. Martin Company, Baltimore, Md.

Benjamin F. Fairless is retiring as chairman of the Board and chief executive officer of United States Steel Corporation, but will continue as a member of the Board of Directors and the Finance Committee of the Corporation. In the industry for over forty years, Mr. Fairless was elected president of U.S. Steel in 1938, and chairman of the Board in 1952.

Hugh J. Casey and **Michael Halpern** were among thirteen engineers awarded honorary engineering doctorates at the final Centennial Convocation of the New York University College of Engineering on May 7. General Casey, chairman of the New York City Transit Authority and secretary of the Schenley Industries, was cited for "his distinguished career as the supervisor of important peacetime projects . . . and his brilliant direction of military engineering activities in the Pacific area in World War II . . . . " Mr. Halpern, vice-president of the Texas Company, New York, and a graduate of the College of Engineering, was hailed as a "distinguished exemplar of the engineer in management . . ."

Frederick H. Dill, of Sewickley, Pa., has been named assistant to the vice-president—engineering research and development—of the American Bridge Division of the U.S. Steel Corporation, with headquarters in Pittsburgh. In this newly created position Mr. Dill will coordinate research and development throughout the Division. He has been with the American Bridge Division since 1929.

John B. Miller of Jacksonville has been elected vice-president of the Florida Engineering Society. Two other newly elected ASCE members are **Thomas L. Bransford,** of Gainesville, secretary, and **Russell DeGrove,** of Jacksonville, treasurer. Harvey F. Pierce is president. Mr. Miller is sanitary engineer with the Florida Board of Health's Bureau of Sanitary Engineering. Mr. Bransford is professor of civil engineering at the University of Florida and Mr. DeGrove is junior partner in the firm, Robert M. Angas & Associates.

Eric Moorehead, structural engineer with Kump Associates, San Francisco, Calif., is establishing his own structural engineering office in Berkeley, Calif.

Hobart G. Mariner, until recently maintenance superintendent for Service Pipe Line Co., Kansas City, Mo., has been appointed assistant to the general manager. He has been with the company since 1940.

Joseph G. Hunter announces the opening of an office as a civil engineering consultant at 350 Sansome Street, San Francisco 4, Calif. Mr. Hunter retired in December as director of the California Public Utilities Commission.

Edward Hiram Anson, senior vice-president of Gibbs & Hill and specialist in railroad construction, receives the New York University College of Engineering Centennial Award "for professional achievements and services to the common good." Mr. Anson who was graduated from the college in 1925, was one of 100 of the College's alumni so honored. Certificates were presented at the Midwinter Centennial Convocation celebrating the College's 100th anniversary. Shown here with Mr. Anson are (left) Henry T. Heald, Chancellor of New York University and (right) Thorndike Saville, dean of the College of Engineering.

(*Continued on page 22*)

Gurley **Current Meters for measuring stream velocity in:**

Fresh water—rivers, streams, canals, lakes

Salt or brackish water—with a newly-designed salt water model

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Industrial waste and sewage—where solids permit ...the Gurley Current Meter is made of non-corroding materials.

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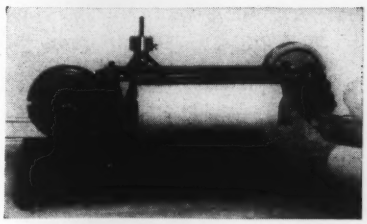
Use Gurley Graphic Water Level Recorders when you need dependable records of reservoirs, hydro plants, sewers and sewage systems, irrigation and stream gaging. *Write for Bulletin No. 50 and details on Gurley Water Level Recorders.*



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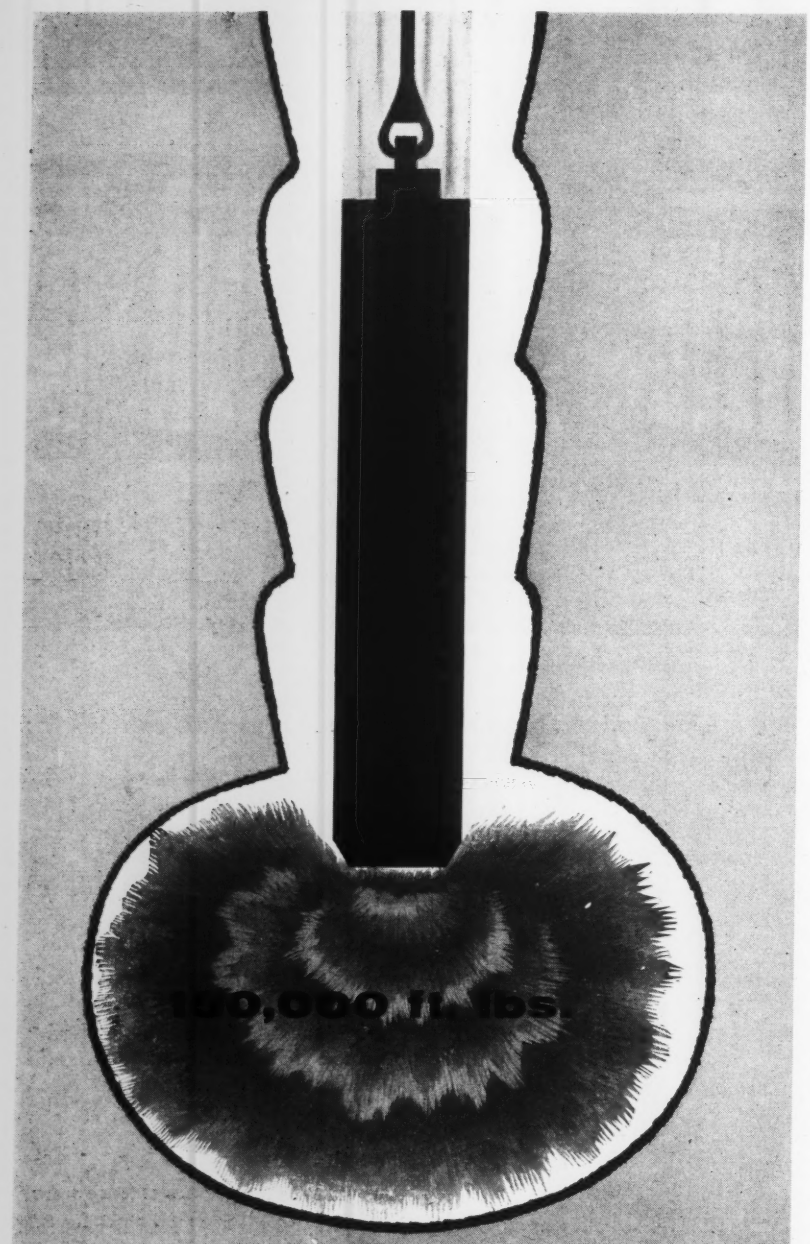

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News of Engineers

(*Continued from page 21*)

William R. Ganser, Jr., structural engineer of the Timber Engineering Co., Washington. D.C., has been advanced to the post of research engineer in the lumber and wood products laboratory. He is a noted author and lecturer on timber construction.

Leon A. Hostetter announces the opening of a civil engineering office at 2321 21st Street, Sacramento, Calif. His specialties will be investigations, reports, designs, cost estimates, and construction engineering for all types of water resources developments. For the past seven and a half years Mr. Hostetter has been special projects engineer and irrigation consultant with the International Engineering Company, Inc., San Francisco.

© *Wesley Swadley*
L. A. Hostetter

William S. Pollard, Jr., has become chief engineer of Harland Bartholomew and Associates, city planners, civil engineers and landscape architects of St. Louis, Mo. Since 1949 Mr. Pollard has been on the engineering staff at the University of Illinois.

Carl I. Aslakson retired from the Coast and Geodetic Survey on May 1 after an outstanding career of more than thirty years. Captain Aslakson's latest assignment was as technical adviser on electronic surveys and geodesy at the Long-Range Proving Ground guided missile range at Cocoa, Fla. In 1952 he received the Department of Commerce Gold Medal for his service to the Survey.

Ora G. Baxter, assistant chief of the operations division, Mississippi River Commission, Corps of Engineers, retired this April, after thirty-six years of federal service. Mr. Baxter has been in the Department of Agriculture, the Bureau of Public Roads and, since 1942, with the Mississippi River Commission at Vicksburg, Miss. He plans to start a consulting practice.

William R. Osgood, for the past five years chairman of the Department of Mechanics at Illinois Institute of Technology, has been appointed head of the Mechanics Department at Rensselaer Polytechnic Institute. He will assume his new duties in July. A graduate of Harvard University, Dr. Osgood has taught and for twenty-one years was in government service in Washington. In the April issue it was erroneously stated that he has been a member of the Rensselaer staff for the past several years.

Frank B. Benzon, president and general manager of Timber Structures, Inc., of California, Richmond, Calif., was elected president of the American Institute of Timber Construction at the organization's recent annual meeting in San Francisco. As chairman of the Interim Organizing Committee, Mr. Benzon was one of the founders of the Institute in 1948.

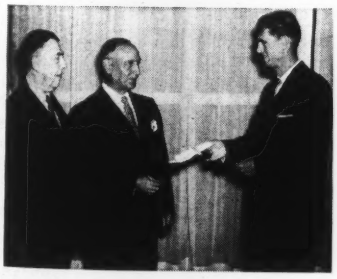
Edward V. Gant has been appointed special assistant to Connecticut's state highway commissioner. He has been associate professor of civil engineering at the University of Connecticut, Storrs, Conn.

Edwin G. Nielsen, since 1952 director of Region 3 (Boulder City, Nev.) for the Bureau of Reclamation, has been appointed assistant commissioner for irrigation and power. Mr. Nielsen, who started work for the Bureau in the Denver office in 1934, was chief of the hydrology division in Denver in 1942 and regional planning engineer for Region 3 in 1945.

Robert F. Blanks, of Denver, Colo., has been elected president of the Colorado Society of Engineers. Mr. Blank is vice-president and general manager of Great Western Aggregates, Inc.

William C. Walsh, junior partner in the firm, Dannenbaum-Walsh, Angleton, Tex., has been appointed chairman of the Ethics and Fair Practice Committee of the Texas Surveyors Association. His committee will write a surveyor's code of ethics and recommend salary and fee schedule for members of the association.

George T. Neuffer has changed the address of his architectural and engineering offices to 1022-1024 South Main Building, 25 South Main Street, Dayton 2, Ohio.



Members Maurice P. Van Buren (left) and Joseph Di Stasio (center) receive the 1955 Concrete Reinforcing Steel Institute Award on behalf of their firm Di Stasio & Van Buren. Vernon P. Jensen, Award Committee chairman, makes the presentation at the Institute's thirty-first annual meeting at the Greenbrier Hotel, White Springs, W. Va.

Wesley C. Pietz has been elected president and managing director of Raymond Concrete Pile Company's Canadian subsidiary, Raymond Concrete Pile Company Ltd., with headquarters in Toronto and district offices in Montreal and Vancouver. Mr. Pietz has been associated with the Raymond Company since 1927 and has been Pittsburgh district manager since 1937. He will be succeeded at Pittsburgh by **Richard O. Marsh, Jr.,** acting district manager at Baltimore for the past year. **Clifford E. Simmons** will be Baltimore district manager.

W. C. Pietz

Jack Y. Long announces the removal of his firm, Jack Y. Long Co., Engineers, to a new building located on 9th Street between Oak and Madison Streets in Oakland, Calif. The firm practices the broad field of civil engineering, including planning and design of buildings, bridges, sub-divisions, streets, drainage and sewage projects. Donald E. Ryan is the second partner in the firm.

(*Continued on page 24*)

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News of Engineers

(*Continued from page 23*)

John W. Hubler, since 1947 head of the department of civil engineering at Washington University, St. Louis, Mo., has resigned to accept the position of consulting engineer with Macomber Incorporated, steel fabricators, Canton, Ohio. With the university since 1942, Mr. Hubler previously taught at Purdue University and Alabama Polytechnic Institute. He is president of the St. Louis Section.

William A. McWilliams has retired as chief engineer of the Delaware State Highway Department and director of the Delaware Memorial Bridge after thirty-one years in the department to accept a post as project engineer on the staff of the Nello L. Teer Company. His assignment with the Teer Company will be a government project in Iceland. **Walter B. McKendrick, Jr.,** formerly assistant chief engineer of the department, will be his successor.

© *Lubitsh & Bungarz*
W. A. McWilliams

Lowell J. Stephenson is returning to the Ohio office of Porter-Urquhart, Associated at Fremont, Ohio. Mr. Stephenson will be resident engineer for the firm's construction section of the Ohio Turnpike until October 31. Recently he was in the company's Oakland, Calif., office.

Robert C. McDowell has been elected a director of the National City Bank of Cleveland, Ohio. Mr. McDowell is president of McDowell Co., Inc., McDowell Co., S.A., and the McDowell Construction Co. of Canada, Ltd.

Frederick C. Gardner, president of Ebasco Services Incorporated, has been elected a director of Electric Bond and Share Company. Mr. Gardner has worked continuously for Ebasco or its associated companies since his graduation from North Carolina State College in 1917. In 1952 he was made executive vice-president, and he has been president since July.

Joseph E. Jenkins is the first full-time city engineer for Orange, Tex. Mr. Jenkins was formerly assistant city engineer for Port Arthur.

Joseph P. Lawlor, president of General Filter Company of Ames, Iowa, and mayor of Ames, was honored by the magazine, *Iowa Business and Industry,* which, in the March issue, selected him as its "Man of the Month."

O. J. Porter and **L. C. Urquhart,** who have been associated since January 1, 1953, with **B. E. Beavin, Sr.,** under the name of Porter, Urquhart and Beavin, announce that they will continue their consulting engineering business under the name of Porter, Urquhart, McCreary and O'Brien with offices in Newark, N.J., New York City, San Francisco, Sacramento, and Los Angeles, Calif., and Fremont, Ohio. **Bruce D. McCreary** will continue as partner in charge of the San Francisco and Sacramento offices, and **Kenneth H. O'Brien** will remain in the same capacity in the Los Angeles office. Mr. Beavin has opened an office in Baltimore as a consulting civil engineer and will be associated with the firm on joint ventures or as consultant on certain projects in the Maryland area.

Raymond C. Nissen, assistant to the chief engineer of the Southern Pacific Co., San Francisco, Calif., has been promoted to assistant chief engineer.

Albert N. Gonsior, director of engineering for P. Ballantine & Sons, Newark, N.J., was one of three engineers receiving "Merit Awards" from Sigma Tau, honorary engineering society, at a recent meeting of the organization in New York City. He was honored for outstanding service to the society.

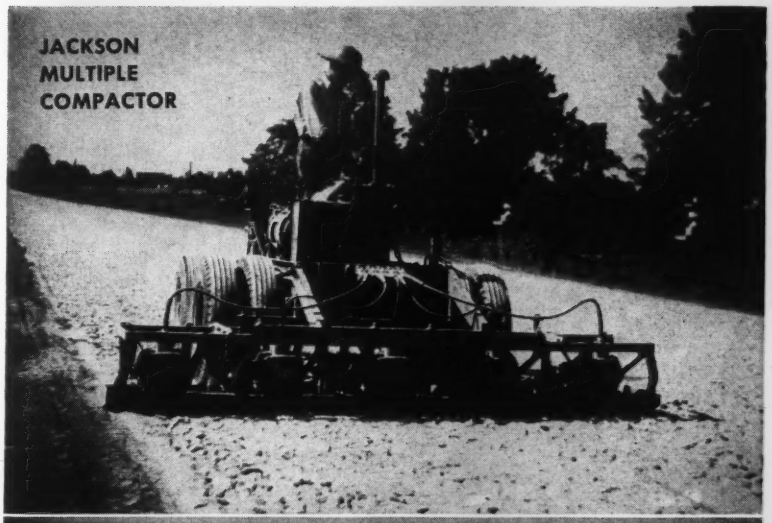
William M. Jaekle, formerly assistant chief engineer of the Southern Pacific Company in San Francisco, Calif., has been made chief engineer of its Pacific Line with headquarters in the same city.

Ernest W. Carlton, professor of structural engineering at the School of Mines and Metallurgy, Rolla, Mo., has been appointed chairman of the civil engineering department to succeed Prof. J. B. Butler who died recently (May issue, page 94). Professor Carlton has been connected

Ernest W. Carlton

with the School of Mines and Metallurgy since 1923. Long active in the Society, he is currently serving a term as Director. He is chairman of the Young Engineers Committee of the National Society of Professional Engineers, and a former president of the Missouri Society of Professional Engineers.

(*Continued on page 27*)



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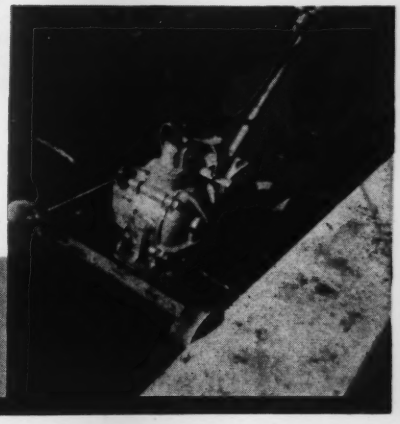

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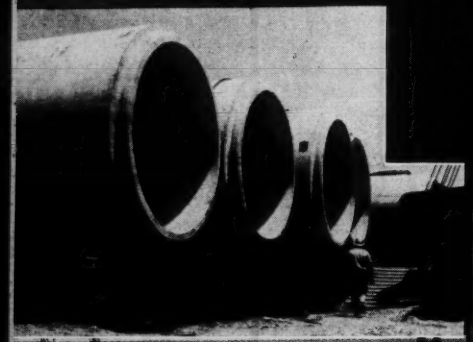
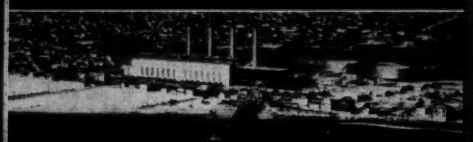
underground
or



Temporary trestle provides runway for gantry crane. Pipe sections are lowered into position through trestle.



AMERICAN'S REINFORCED CONCRETE PIPE OFFERS EQUAL ADVANTAGES IN PERMANENCE, ECONOMY AND EASE OF INSTALLATION

For an important second subaqueous installation at the Redondo Steam Station, Southern California Edison Company again chose American's 120" precast reinforced concrete pipe with rubber gasket joints. In the parallel intake and discharge lines, ocean water is circulated at an average flow of 400 second feet as part of the steam condensing system.

In addition to sustained hydraulic capacity, corrosion resistance and freedom from maintenance, this project demanded a pipe easy and accurate in placement with maximum joint flexibility. All of these requirements were amply and safely met with American's subaqueous pipe.

Whether your pipeline is to be underground or underwater, you'll find a class of American pipe designed and manufactured specifically to meet your needs. Take advantage of our 45 years of experience in water supply line engineering . . . write for any desired information. P. O. Box 3428, Terminal Annex, Los Angeles 54, California.

PIPE AND CONSTRUCTION CO.

Main Offices and Plants: 4635 Firestone Blvd., South Gate, Calif. District Sales Offices and Plants: Hayward, Calif. • San Diego, Calif. • Fontana, Calif. Mail Address: P. O. Box 3428 Terminal Annex, Los Angeles 54, Calif. • Phone LOrain 1-2345

News of Engineers

(Continued from page 25)

Harold Kramer, since 1935 engineer and construction superintendent for the Thomas Crimmins Contracting Co., announces that he is joining **Frank W. Babor** and **George O. Stiles** in forming a contracting firm, Babor, Kramer and Stiles, with headquarters in the Grand Central Terminal Building, New York. The new firm will engage in heavy construction work including bridge and building foundations, sewer and utility projects, highway and site improvement.

William Marshall, Jr., an architect, has been admitted to partnership in the firm of Lublin, McGaughy & Associates, Architects and Consulting Engineers, in Norfolk, Va. Mr. Marshall has been with the firm for the past four years.

Karl Terzaghi, world-famed authority in the field of Soil Mechanics, received the annual award of the Engineering Societies of New England at the organization's annual meeting and dinner held on April 21. Dr. Terzaghi has taught here and in Europe, where, from 1929 to 1938, he was at the Technische Hochschule in Vienna. He has been professor of civil engineering at Harvard University since 1947. He is an Honorary Member of ASCE and holder of many other honors.

Irving B. Rau announces the opening of an office for the practice of civil and structural engineering at 612 Queen and Crescent Building, New Orleans, La. Mr. Rau was formerly with R. P. Farnsworth & Co., Inc., in the same city.

Willard E. Simpson was named "Engineer of the Year" by the Bexar chapter of the Texas Society of Professional Engineers at a dinner held February 26. Mr. Simpson is president of W. E. Simpson Co., San Antonio, Tex.

Ernest F. Tippetts, Robert W. Abbett, Gerald T. McCarthy, James H. Stratton, and **William Z. Lidicker,** partners in Knappen-Tippetts-Abbett-McCarthy, announce a change in the name of the firm to Tippetts-Abbett-McCarthy-Stratton, Engineers. Frank Lilien, Leonard A. Lovell, Thomas J. Frater, Walther Prokosch and Barnett Silveston have been admitted as associate partners. The firm has its headquarters in New York.

Godfrey Lutz has been appointed director of construction research for the Turner Construction Company, with which he has been connected since 1933. His headquarters are in New York.

Vincent J. Vitagliano announces the opening of a private consulting practice, with offices at 4055 Duryea Avenue, Bronx 66, N.Y. He has been teaching civil engineering at Manhattan College since last February.

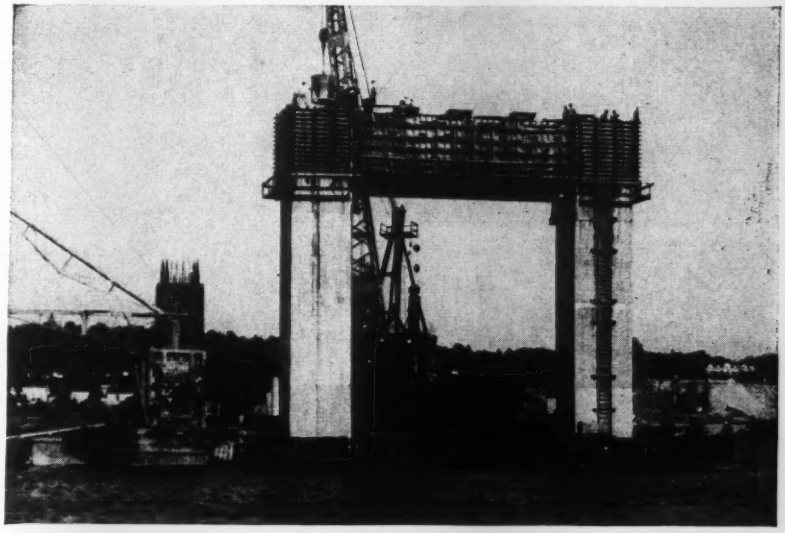
Kenneth E. Fields, Brigadier-General, Corps of Engineers, has succeeded Maj. Gen. K. D. Nichols as general manager of the Atomic Energy Commission with headquarters in Washington D.C. General Fields was formerly director of the AEC'S Division of Military Application.

Douglas E. Parsons, chief of the Building Technology Division of the National Bureau of Standards, has been awarded the Department of Commerce's Gold Medal for Exceptional Service. A member of the Bureau's staff for thirty years, Mr. Parsons was cited for "exceptional scientific attainments in the field of building research."

Charles H. Wagner has been assigned to the Seattle District office of the Corps of Engineers as chief of the construction division. Until recently he was resident engineer on construction of Chief Joseph Dam on the Columbia River.

Robert L. Cashen, vice-president of the H. K. Ferguson Co., of Cleveland, Ohio, has been elected vice-president and Eastern district manager of the company.

Evan William Vaughan, until recently hydraulic engineer with Canadian-Brazilian Services, Toronto, Canada, has accepted an engineering position with Parsons, Brinckerhoff, Hall and Mcdonald, with headquarters in New York.



Why They Used Plastiment at Tappan Zee...

Using varying proportions of Plastiment Concrete Densifier, the engineers were able to keep 7½-foot wall lifts workable enough to permit re-vibration as long as 8 to 10 hours after placement...

Aiming at higher density, bond to steel, elimination of voids and honeycombs, and the reduction in heat of hydration with amplifying reduction in volumetric changes, they selected the admixture on the basis of successful re-vibration performance in concrete tankers, dry cargo ships, and New York's Pier 57, where Plastiment contributed special properties to a project designed for absolute watertightness.

Whether or not you employ re-vibration, performance records have shown consistently higher properties of strength, density, bond to steel, and resistance to cracking and abrasion wherever Plastiment has been used.

For complete details on how Plastiment operates to produce a uniformly high quality concrete, send today for a copy of the illustrated booklet, "Plastiment Concrete Densifier." Our engineers will be glad to tell you how Plastiment can help you on your present job.

CONSULTING ENGINEERS AND DESIGNERS:
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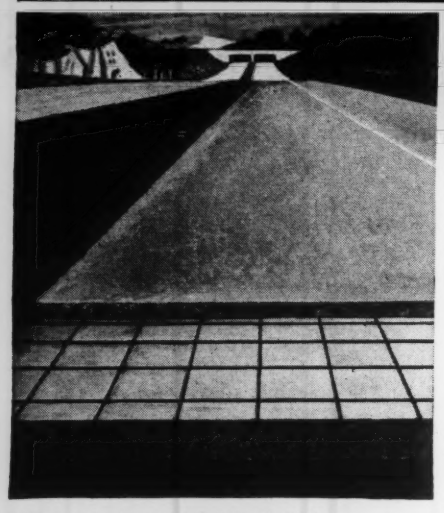
Sika

PLASTIMENT CONCRETE DENSIFIER

SIKA Chemical Corporation, Passaic, New Jersey

BRANCH OFFICES: PITTSBURGH, SALT LAKE CITY, MONTREAL, CHICAGO, BOSTON, WASHINGTON, D. C., PANAMA · DEALERS IN PRINCIPAL CITIES

50 MILLION VEHICLES A YEAR
can't pound New York State Thruway apart



LIKE A 3-LAYER CAKE—

that's how the concrete pavement for the New York State Thruway is built up. First to go down is a foot-thick base layer of gravel. Six inches of concrete is then poured over the gravel. 11′ 6″ x 15′ sheets of American Welded Wire Fabric come next to tie the slab tightly together, add strength, and reduce cracking. A final layer of concrete, 3″ thick, finishes the job.

In the next six months 24 million vehicles will rumble over the longest super highway of them all—the New York State Thruway. Traffic experts expect this new 426-mile, divided highway to carry 50 million vehicles in 1956, and they expect that staggering figure to show *a marked increase* in the future.

Obviously this road needs extra strength—and it gets it from a tough backbone of American Welded Wire Fabric Reinforcement. For equal slab thickness of concrete the use of American Fabric increases the the strength of a concrete pavement slab about 30%. It insures less cracking and longer life.

American Welded Fabric adds strength and life to the Pennsylvania Turnpike, the Indiana Turnpike, the Kentucky Turnpike, the Ohio Turnpike, the Chicago Expressway, and countless secondary roads and city streets. Specify it for all *your* paving—both cement and asphaltic concrete. American Welded Wire Fabric is now available in wide sheets for continuously reinforced concrete pavements in wire sizes up to and including ½″ in diameter at 2″, 3″, 4″ and 6″ on centers.

BE SURE TO ASK "is it Reinforced"

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
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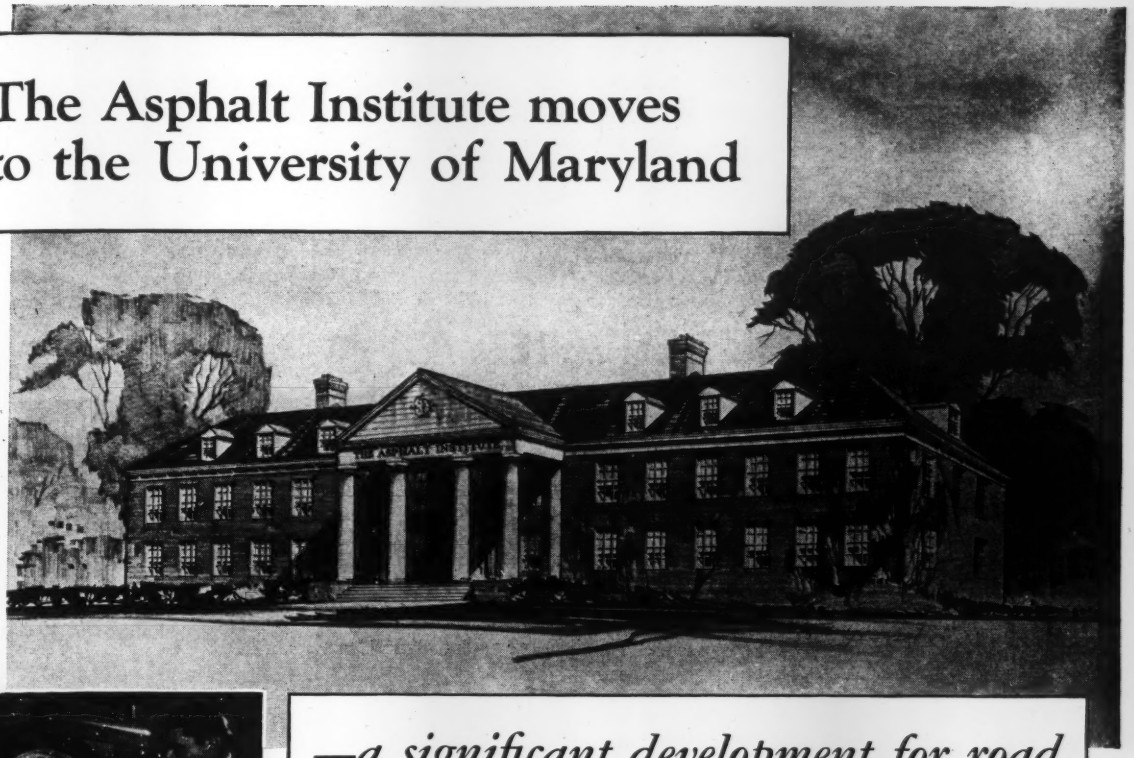
USS

EVERY TYPE OF REINFORCED CONCRETE CONSTRUCTION NEEDS

USS AMERICAN WELDED WIRE FABRIC

UNITED STATES STEEL

The Asphalt Institute moves to the University of Maryland



—a significant development for road builders and other Asphalt users

Universal testing machine for applying compressive loads to specimens of Asphalt paving mixes.

Unique multiple-temperature control apparatus for laboratory testing of Asphaltic materials.

As a member of The Asphalt Institute, The Texas Company takes pride in calling attention to the Institute's new, larger and better-equipped quarters on the campus of the University of Maryland. The new building was officially dedicated early this month.

To America's road builders in particular, but to all other asphalt users as well, this move is important because it substantially increases the capacity of The Asphalt Institute to serve them.

The new laboratory, which occupies the entire first floor of the Asphalt Institute Building, is several times as large as the former "lab" and it is equipped with a number of new pieces of testing equipment.

At the rear of the building, there is a large tract of ground which will be used to test the performance of asphalt under actual service conditions.

With the nation on the threshold of the biggest highway construction program in its history, this substantial enlargement of the capacity of The Asphalt Institute to serve road builders is particularly timely.

THE TEXAS COMPANY, Asphalt Sales Div., 135 E. 42nd Street, New York City 17

Boston 16 • Chicago 4 • Denver 1 • Houston 1 • Jacksonville 2 • Minneapolis 3 • Philadelphia 2 • Richmond 19

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TEXACO ASPHALT

COMPLETE POOL DELIVERED AT POOL SITE IN TRAILER TRUCK.

Costs no more than a good medium priced automobile

Revolutionary engineering design cuts construction costs in half.

Complete pool package is delivered at your pool site in trailer truck, including all fittings, and filtration system which purifies pool water completely every 24 hours. Construction requires no special equipment and can be done with common labor. Specifically designed pre-cast concrete wall sections grooved to fit into each other solves cost problem. Pool walls are scientifically pre-stressed to prevent cracking. New method puts swimming pools in reach of all budgets. Same building procedure applies to largest type pools as well as family type private pools.

EVERYTHING YOU NEED FOR SWIMMING POOLS

- **Filtration Systems**
- **Deck Equipment**
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We can refer you to qualified architects, engineers and builders. Send coupon for new pool booklet and catalog.

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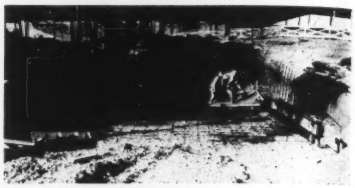
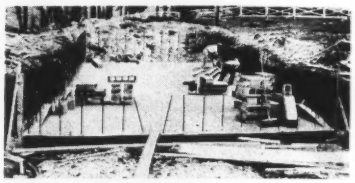
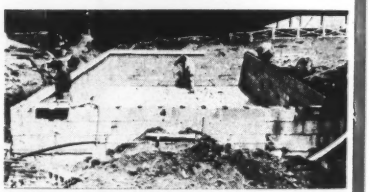
SWIMMING POOL BUILT COMPLETE IN SEVEN DAYS



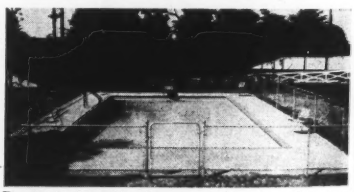
Excavation for pool showing steel reinforcement for floor and inside pool walls.



Steel side rods are ready for specially grooved pre-cast wall sections to be placed over them. No heavy construction equipment needed. All work can be done with common labor.



Walls being pre-stressed by tightening nuts above plates of sheet steel, after concrete mixture has been poured inside pre-cast concrete sections. Prevents cracking. No wooden or other forms needed.



The finished pool has been coated inside with a mixture of fine marble aggregate and white cement. Tile border and brick coping around top.

CE

Gentlemen:

Please send me complete information about your low cost, 7-day swimming pool.

Name.....

Address.....

City.....**State**.....

☐ **Please send me a copy of your Pool & Equipment catalog.**

☐ **Please check if you now own a swimming pool.**

do you know that

Nominating ballots for ASCE officers will be canvassed at Society Headquarters on June 30? Have you indicated your choice and mailed in your ballot?

Disposal of the long-life waste products of atomic fission may limit the extent to which atomic power can be used? In an article on the subject in the July issue Joseph Lieberman, of the AEC, says containment of atomic wastes in underground storage tanks is our only present (though impractical) solution.

The parking problem is not confined to the United States? At a meeting of the World Touring and Automobile Organization, held in Washington this May, delegates from thirty countries heard complaints extending from New Zealand to Turkey on lack of parking space in cities and towns. Work on an underground parking garage is under way in Milan, and parking meters have been installed on the streets of Cairo, it was revealed.

A $200 billion public works program is a possibility? In the opinion of the Department of Commerce, non-federal public works expenditures must be increased to $20 billion a year for the next ten years. This more than doubles the 1954 record volume of $8.5 billion. The Department's estimate is based on reports of various groups, public and private. See page 84 for the breakdown of figures.

Florida will build a $200 million state-long turnpike? The Florida Legislature has just passed a bill providing for construction of a turnpike from the Miami area northward to a point near Jacksonville via the inland route. Another amendment provides for building a leg of the turnpike to Pensacola for connection with the projected Alabama turnpike.

A new bridge will replace Telford's historic Conway Castle Bridge? Thomas Telford's world famous suspension span over the Conway River in North Wales will soon be torn down in favor of a modern structure of greater capacity (a 31-ft roadway as against one lane 17½ ft wide). The pioneer structure, one of the first wrought-iron suspension spans, was completed in 1826. The new bridge will be a 310-ft-long steel-arch span. Telford's bridge was pictured and described in the April 1937 issue.

Africa is the only continent with a clear surplus of hydro power? In speculating as to how this surplus energy can be transmitted from Central Africa to Europe or wherever it is needed, Dr. L. G. Brazier, of London—addressing the recent 69th annual meeting of the Engineering Institute of Canada—said that it may be found feasible to use the hydro power for producing plutonium to be sent where required as packaged energy.

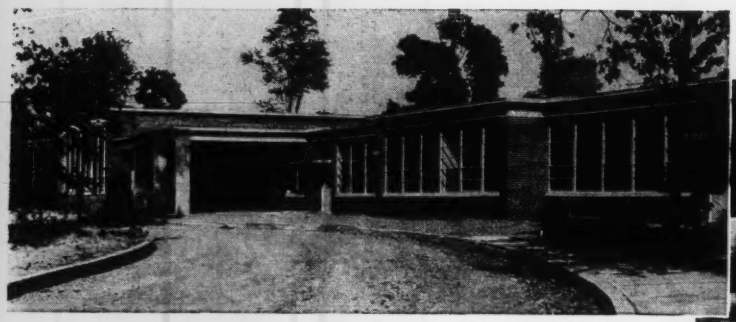
Work will start this month on the U.S. Air Force Academy? This June first dirt will be moved as a preliminary to constructing the Air Force's $125 million Academy in the shadow of the Rockies near Colorado Springs. The project will have training facilities for 2,640 cadets. If all goes as expected, it will be open for classes in the fall of 1957.

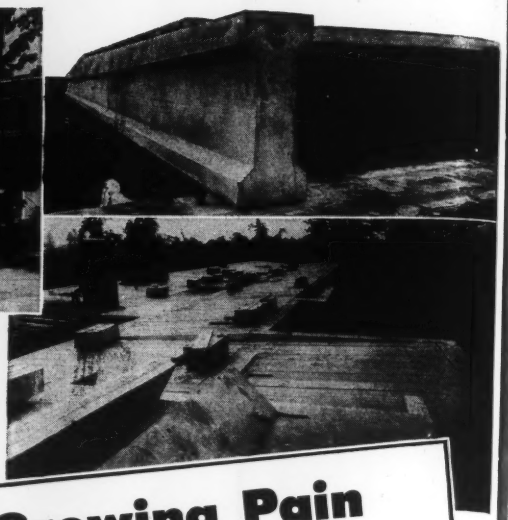
This June's graduating classes will launch 21,569 engineers from ECPD-accredited schools? Included are 3,840 civil, 2,050 chemical, 4,835 electrical, 5,250 mechanical, 666 mining and metallurgical, and 1,290 industrial engineers. About 7,200 engineers, or one-third of the graduating class, are in the ROTC. The source for these figures is the "Engineering and Scientific Manpower Newsletter."

An ASCE committee is aiding in the fight to save the President's $101 billion highway program? In the struggle to enact national highway legislation retaining important features of President Eisenhower's original plan, the ASCE Committee on a National Highway Program has been testifying before Senate and House committees. Salient features of the testimony are reported by our Washington representative (page 78).

A $5 million fund has been set up for research in the physical sciences? The Alfred P. Sloan Foundation announces the establishment of a $5 million program to promote basic research in the physical sciences—that is, disinterested curiosity about the laws of nature. Both the principal and interest will be devoted to the program, which will be carried out in university laboratories.

Bids are being asked on a job in Pakistan? The Government of Sind (Pakistan) is asking for bids by mid-July on the Gudu Barrage, a $12,600,000 project on the Indus River about 100 miles north of Sukkur. Interested builders should write the Chief Engineer, Gudu Barrage, 9 Napier Barracks, Karachi 4, Pakistan.





HERE IS THE ULTIMATE in concrete prefabrication, including precast long-span channel slabs, precast columns, joists, roof units, spandrels, sunshades, every unit field practical for fast erection. GERTRUDE C. FALWELL SCHOOL, Mt. Holly Township, N. J. Members precast with 'Incor' by FORMIGLI ARCHITECTURAL STONE CO., Williamstown Junction, N. J., erected by Formigli's Structural Service. Architects, MICKELWRIGHT & MOUNTFORD, Trenton; General Contractor, THOMAS PAGAN, INC., Pennsauken, N. J.

Rx for a Nationwide Growing Pain

Concrete Provides Time- and Money-Saving Solution for Critical School Shortage

★

AMERICA has a case of growing pains, and nowhere more so than with schools. Sound design and building know-how is avoiding skimpy construction in meeting urgent need. Careful analysis almost invariably shows that concrete provides utmost value in attractive, durable, fire-safe structures.

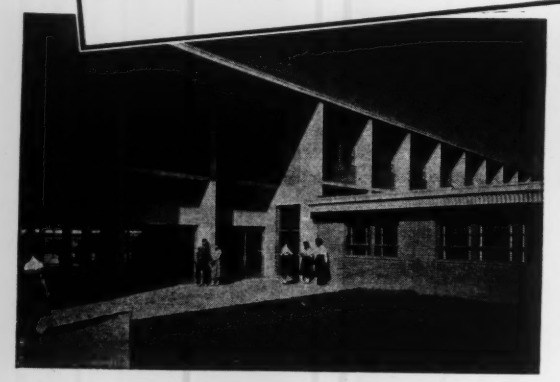
Such is concrete's flexibility that it is possible to meet almost any school-building budget and assure a structure of highest quality from every standpoint. Two examples:

One represents prefabricated concrete construction at its best, with factory-made, quality-controlled members, produced to closest tolerances, for fast erection with minimum supervision . . . quality concrete elements, produced at assembly-line speed—and economy—with 'Incor'* 24-Hour Cement.

The other is a reinforced concrete school whose outstanding architectural treatment expresses in clean, uncluttered line the sound structural values which make concrete the first choice for schools.

Two of many fine, new schools, built with Lone Star Cements, providing the finest in modern construction at minimum cost, initially and through the years.

*Reg. U.S. Pat. Off.



WEST CHARLOTTE HIGH SCHOOL, Charlotte, N. C., is an outstanding example of attractive contemporary design in concrete. Vertical lines of exposed columns lend interest to the façade of this beautiful, reinforced-concrete structure, which well deserves its merit award as a national contest winner. Architects, GRAVES & TOY; General Contractor, C. D. SPANGLER CONSTRUCTION CO., INC.; Ready-Mix Lone Star Cement Concrete supplied by JOHNSON McMILLAN CONCRETE CO., INC.—all of Charlotte.

LONE STAR CEMENTS COVER THE ENTIRE CONSTRUCTION FIELD

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LONE STAR CEMENT, WITH ITS SUBSIDIARIES, IS ONE OF THE WORLD'S LARGEST CEMENT PRODUCERS: 18 MODERN MILLS, 141,600,000 SACKS ANNUAL CAPACITY

AEC steps up development of nuclear reactors

L. F. C. REICHLE, Assistant Director

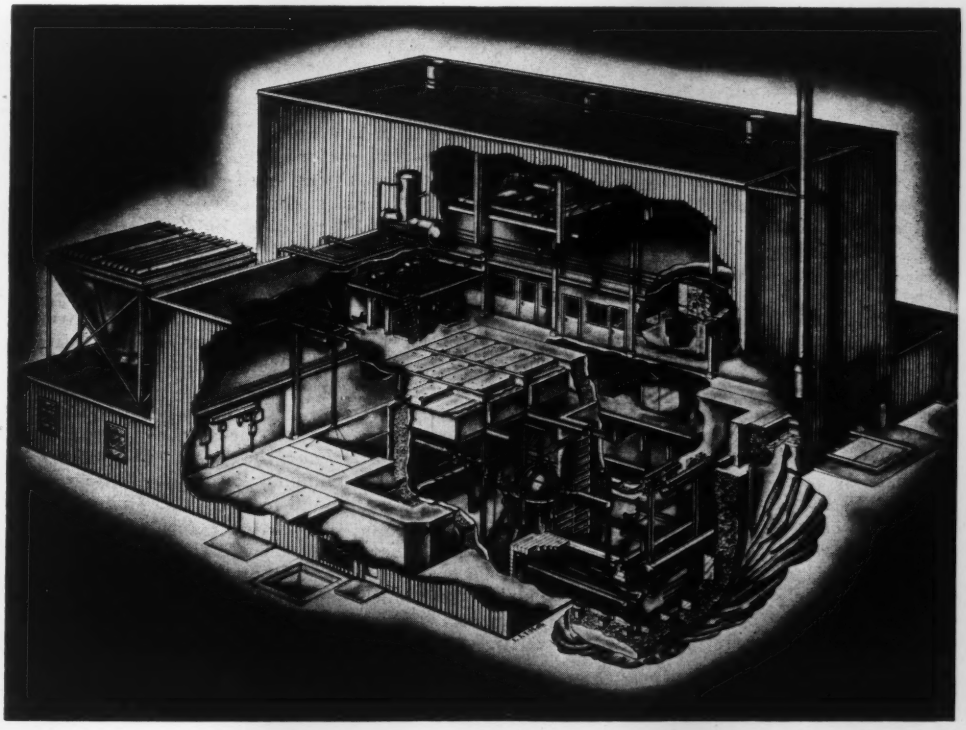
Division of Reactor Development, U.S. Atomic Energy Commission, Washington, D.C.

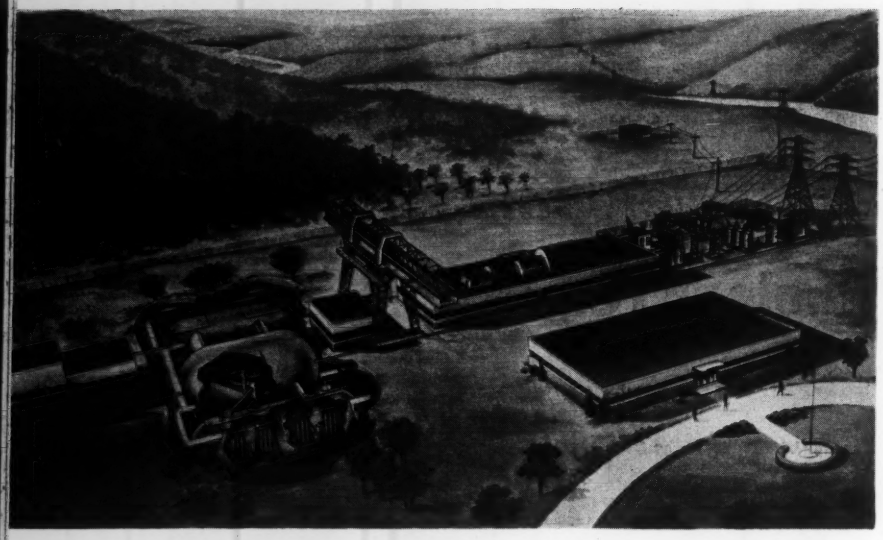
A program to advance the frontiers of knowledge in power reactor technology is being vigorously implemented by the Atomic Energy Commission. Through the Power Demonstration Reactor Program it is encouraging industry to assume responsibility for the development, construction, and operation of full-scale nuclear power reactors. It is giving particular emphasis to the problem of making reactors safe for commercial use.

It is the Government's responsibility to advance the frontiers of knowledge in the field of reactor development. That is the basic premise of the AEC's power reactor program. A corollary is that it is industry's role to build full-scale power reactors.

The 5-year power reactor development program is an expression of the role of government in supporting the development of a new technology which involves at the beginning heavy expenditures for research and development and the use

In homogeneous reactor, fuel is in liquid form, an advantage in low-cost fuel element preparation and economical chemical processing. These reactors also may breed new fissionable material, that is, produce more fuel than they consume. This sketch is of Homogeneous Reactor Experiment No. 2, under construction at Oak Ridge National Laboratory by Union Carbide & Carbon Chemicals Co.





Commercial central-station atomic power plant of 60,000-kw capacity, nation's first, is under construction at Shippingport, near Pittsburgh, Pa., as joint project of AEC and Duquesne Light Company. In this artist's sketch, from left to right appear buildings for handling fuel elements, atomic reactor and heat exchangers, maintenance building and overhead crane, turbogenerator building, switchyard, transformers, and transmission line. Atomic pressurized water reactor (PWR) and heat exchangers are to be enclosed below ground in concrete and steel enclosure. Fuel contained in core is uranium, in upright bottle-shaped pressure vessel. Water under pressure will be pumped through core, where it will be superheated, and thence piped to four heat exchangers. Two of these are visible in foreground. A heat exchanger, other water is turned into steam to drive turbines.

of costly equipment and experiments. The AEC's Power Demonstration Reactor Program indicates a way in which it is trying to encourage industry to pick up responsibility for the private development, construction, and operation of reactors.

The AEC's 5-year Power Reactor Program was presented to the Joint Committee on Atomic Energy in February 1954 and approved by the Committee in March 1954. This program is proceeding essentially on schedule as outlined in the *Report of the Subcommittee on Research and Development on the Five-Year Power Reactor Development Program Proposed by the Atomic Energy Commission*, issued in March 1954. It calls for five specific reactor development projects and advanced engineering development estimated to cost a total of approximately $200 million over the period from fiscal year 1954 through the fiscal year 1958. There have been no technical developments since the initiation of this program which justify any basic change in its content at this time. All concepts currently under intensive investigation continue to show promise of eventually permitting production of economically competitive nuclear power.

The pressurized water reactor, as the first U.S. full-scale nuclear central-station power plant, will provide reliable cost data on the construction, operation, and maintenance of a large nuclear power plant. Responsibility for the design, development, and construction of the pressurized water reactor has been assigned to Westinghouse. The Duquesne Light Company will furnish a site for the project, build and operate a new turbogenerator plant, operate the reactor portion of the plant, and assume up to $5 million of the cost connected with the development and construction of the reactor portion of the plant. Also, Duquesne will purchase at 8 mills per kwhr net electricity put on its grid.

Stone & Webster Engineering Corp., under subcontract to Westinghouse, is designing the reactor plant, buildings, and facilities. Burns & Roe has been engaged by Duquesne to construct the turbogenerator part of the plant.

Approximately 50 percent of the construction and fabrication of the pressurized water reactor is expected to be performed under fixed-price contracts. The plant is scheduled for completion around the middle of 1957.

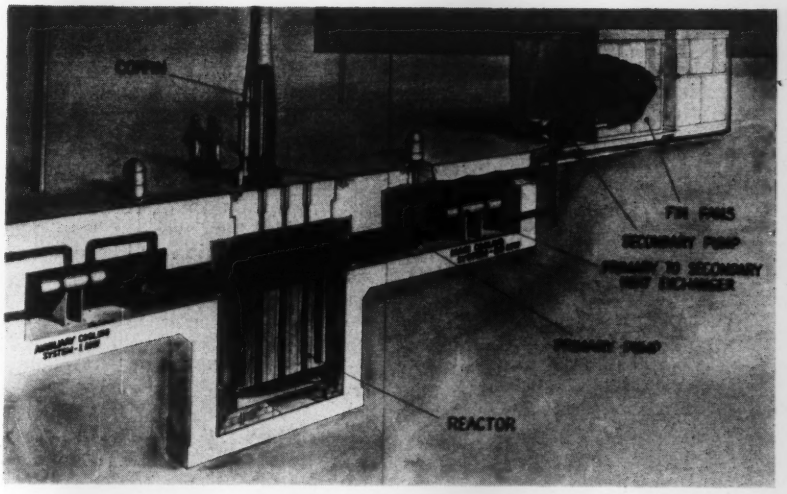
Boiling-water reactor experiments (Borax I) were begun at the National Reactor Testing Station under the direction of the Argonne National Laboratory in 1953. These experiments, in which run-away conditions were imposed upon the reactor, were resumed in June 1954. One final power excursion was performed on July 22, 1954, during which the power rose to well over a million kilowatts in a tenth of a second and resulted in the destruction of the reactor core and some associated equipment. The conditions imposed in this final excursion were much more severe than would occur normally in reactor operation.

A second boiling reactor experiment (Borax II) was constructed last summer and began operating during October 1954. This experiment was designed as a semipermanent facility to demonstrate certain operational characteristics of a boiling water system. It operates at 6,000 kw of heat and 300 psi.

A prototype experimental boiling-water reactor will be constructed at the du Page County site of the Argonne National Laboratory. The reactor, which will produce 20,000 kw of heat and 5,000 kw of electricity, will be placed in a gas-tight steel housing of about 400,000-cu ft capacity. Specifications require the system to be leak tight so that the possibility of using heavy water may be explored without undue risk of loss of heavy water. Architect-engineer work for the reactor building has been awarded on a lump-sum contract to Sargent & Lundy of Chicago, Ill. The Allis Chalmers Manufacturing Company has been awarded a lump-sum contract for the design, construction, and installation of the power generating and heat transfer equipment. The reactor is scheduled to produce power by the end of 1956.

A sodium graphite reactor experiment is being constructed by North American Aviation, Inc., at its Santa Susana, Calif., site. NAA is contributing 25 percent of the estimated $10 million cost of the project. The reactor is to begin operation early in 1956.

This project is designed to determine whether nuclear power plants using a graphite moderator and sodium coolant are as promising as they appear to be. Design of the sodium graphite reactor is essentially com-



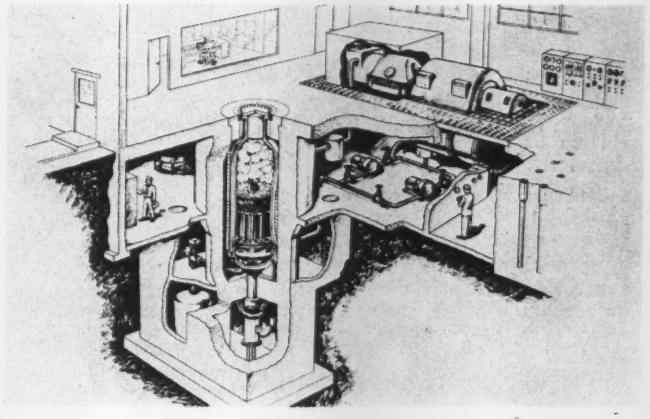
Sodium graphite reactor experiment, which will generate 20,000 kw of heat, is under construction by North American Aviation, Inc., at its Santa Susana site. Reactor will be fueled with slightly enriched uranium. It will be graphite moderated, and heat will be removed from core by liquid metallic sodium. In final development of this type of plant, devices for dissipating heat to air in experimental plant, would be replaced by turbogenerator.

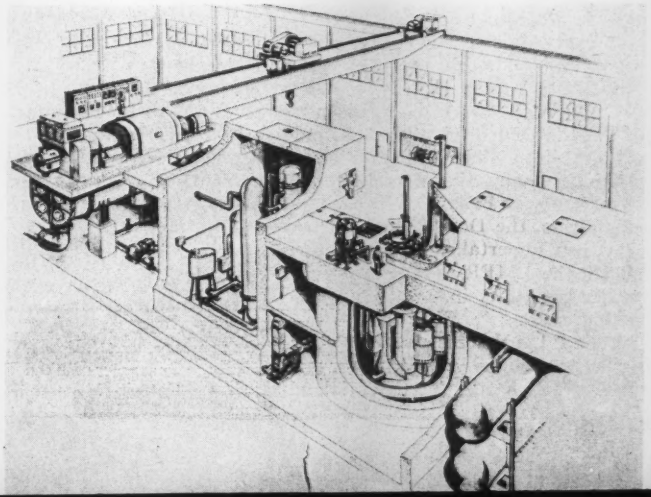
plete and construction is under way. In addition, a large number of tests are being conducted of sodium pumps, fuel handling equipment, fuel rod cladding and assembly, and zirconium welding and reactor physics.

The homogeneous reactor is the subject of another experiment. Homogeneous Reactor Experiment No. 1, which was dismantled in the spring of 1954, began a series of experiments to determine the feasibility of a reactor system in which the ultimate advantages are low cost, due to the elimination of fuel element fabrication, and simplified design and economical chemical processing. The Homogeneous Reactor Experiment No. 2 is being constructed in the same building that housed HRE No. 1. A mock-up for engineering tests is almost completed and will be ready for operation soon. HRE No. 2 is scheduled to begin operation in the spring of 1956 at about 10 megawatts, with a reflector. Later it is planned to increase this power level to 20 megawatts or more, using thorium or uranium in a blanket.

Erection of the underground steel-lined reactor cell has been completed, and installation of the low-pressure system is in process. · Contracts have

Experimental boiling water reactor, seen in artist's sketch, has tall cylinder in center containing uranium fuel assemblies. There water is converted to steam, and is conducted to turbine to drive generator. Below turbo-generator set is condenser and pump to recirculate water through leak-proof circuit to reactor.





First token electric power from nuclear fuel came from experimental breeder reactor (EBR No. 1) at National Reactor Testing Station in Idaho. Pictured here is EBR No. 2, construction of which will begin next January at Idaho Testing Station. Plutonium fuel elements will be used. Capacity of nearly 20,000 kw is 60 times that of first experimental breeder reactor.

been awarded and fabrication started on all major equipment.

Experimental fast breeder reactors are also being studied. The Experimental Breeder Reactor No. 1, which is capable of producing more fissionable material than it consumes, began operation in 1951. This reactor, designed and operated by Argonne National Laboratory, has been operating on two highly enriched uranium cores. A third core, of plutonium, is to be loaded into the reactor this spring.

The Argonne National Laboratory is proceeding with the development of an Experimental Breeder Reactor No. 2 with a heat output of 62,500 kw and an electrical output of 15,000 kw. Construction of this reactor is scheduled to start in January 1956, and operation is to begin in 1958. A building has already been completed at the National Reactor Testing Station to house a critical assembly for the Experimental Breeder Reactor No. 2. The critical assembly, called a zero power reactor, will begin operation during the summer of 1955. A half-scale working model of EBR No. 2 has been constructed at Argonne to demonstrate the engineering feasibility of the design of the reactor. The model will begin operation during the spring or early summer of 1956.

Construction of a building for the fabrication of plutonium fuel elements will begin this spring. Bids were invited February 25, 1955, and a contract was let in April 1955.

Other reactor approaches are being investigated. Preliminary design studies on two other reactor types are progressing in a very encouraging manner. If this continues, we will soon reach the stage where another reactor experiment might be considered.

The first of these is the liquid metal fueled reactor (LMER) using graphite as a moderator and a solution or slurry of uranium in a liquid metal as fuel. The Brookhaven National Laboratory has carried the major responsibility for this approach. The Babcock & Wilcox Company, under subcontract to Brookhaven, is studying data and calculations to determine technical feasibility and to identify additional engineering data that may be necessary to evaluate the concept. In addition, the Dow Chemical Company has undertaken a contract to modify the LMFR design to provide greater versatility in core loading and cooling.

A second of these is a reactor utilizing hydrocarbons as moderator and coolant. Some of the potential advantages are operation at higher temperature without problems of corrosion. North American Aviation has been studying this approach.

Power Demonstration Reactor Program

On January 10, 1955, the AEC announced a Power Demonstration Reactor Program to bring private resources into the development of engineering information on the performance of nuclear power reactors and to advance the time when nuclear power will become economically competitive. This program differs basically from AEC's invitation to industry of a year ago. Last year industry was requested to participate in the construction and operation of a specific nuclear power plant—the Pressurized Water Reactor—which the AEC itself would own and in respect to which it would be responsible for all development work. This year the AEC proposes to place primary responsibility on industry in the sense that the new invitation asked for proposals under which industry itself would design, develop, and operate the reactor, with AEC providing only assistance, if necessary.

Under the Power Demonstration Reactor Program, AEC will consider, within the limits of available funds, providing the following kinds of assistance:

1. Waive charges for the loan of source and special nuclear materials up to an agreed amount for a period of seven years from July 1, 1955. Licensees will be required to pay for materials consumed and for services performed by AEC.
2. Perform without charge agreed upon research and development work in AEC Laboratories.
3. Enter into research and development contracts under section 31(a) of the Atomic Energy Act of 1954 for technical and economical information resulting from reactors evolved by the program. Amounts to be paid by the AEC will be fixed in advance.

Proposals received will be evaluated on the basis of: (*a*) contribution toward achieving economically competitive power, (*b*) cost to AEC, (*c*) risk assumed by maker of the proposal, (*d*) competence and reliability, and (*e*) assurance against abandonment. Before the April 1 deadline, proposals were received from:

1. Yankee Atomic Electric Company
2. Nuclear Power Group (made up of American Gas & Electric Service Corporation, Bechtel Corporation, Commonwealth Edison Company, Pacific Gas & Electric Company, and Union Electric Company)
3. Consumers Public Power District
4. Detroit Edison and others

Some time following evaluation of the responses received for the April 1 deadline, the Commission will decide on a date if a second round of proposals is desirable.

Reactor safety emphasized

Products of nuclear fission are toxic because of their radioactivity. In the operation of a reactor these highly toxic fission products accumulate at a rate directly proportional to the operating power of the reactor. A remarkable record of safety in the operation of reactors has been achieved, but only because considerable time has been given to designing in reactors features contributing to safe operation and because great care has been given to safe operating procedures.

A program has been initiated for the testing of reactors under transient conditions, i.e., conditions of sudden increases in power levels. A facility for this purpose is being built at the National Reactor Testing Station. In this facility, the mechanisms of energy release during reactivity will be studied, and the effects of varying water depth and reflector construction will be investigated. Cores for proposed research reactors will be tested.

North American Aviation is planning an experimental program consisting of the construction of a small water boiler to determine the maximum amount of excess reactivity that can safely be introduced into such a reactor and the maximum of self-regulation involved.

Inspection program initiated

To assure that reactors are operated safely, the AEC initiated last spring an inspection program. This program includes an annual inspection of all reactors and critical facilities in operation or scheduled for operation. To date 17 such reactors or facilities have been inspected.

The Advisory Committee on Reactor Safeguards continues advising the Committee on all matters relating to the safe operation of reactors. Since its organization in June 1953, it has held nine meetings.

On March 15 and 16, a meeting was held at the invitation of the AEC of 10 executives from the four major associations of fire and casualty underwriters. These executives are now studying the problem of the extent to which private insurance companies will be willing to underwrite risks resulting from reactor operation. Their report will contain conclusions reached and will deal specifically with the problem of necessary legislation.

W. H. ELLISON

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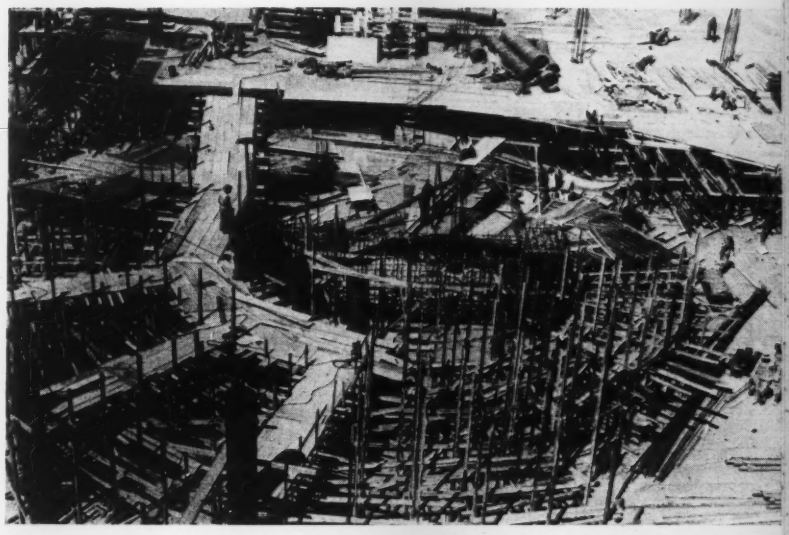
PARKING GARAGE built for $5.38 per sq ft

The problem of parking continues to plague the major areas of the country. San Franciso appears to have found at least one solution in its nine-story, self-service Downtown Center Garage. This structure cost $2,250,000 and has 1,200 parking positions. Of special structural interest is the prestressed concrete pylon which resists earthquake forces. Access to all nine floors is by concentric ramps—an inner down ramp and an outer up ramp. The framing is flat plate and columns.

Parking is of self-service type and customers drive their cars over the adjoining circular up and down ramps located at the exterior corner of the building. The maximum turning diameter of the outer (up) ramp is 93 ft 0 in. and the minimum turning diameter of the inner (down) ramp is 38 ft 0 in. See Fig. 1. Clearance between curbs on the up ramp is 11 ft 0 in. and on the down ramp is 12 ft 6 in. Up and down traffic moves in the same direction but the divided ramps have opposing slopes on a 10-percent grade. The big majority of the stalls are accessible without moving any other car. Ramp supports are placed on inner and outer edges of ramps and on the center dividing strip. Story heights generally are 8 ft 6 in. floor to floor.

Filling stations are located on the first and fifth floors. Washing, greasing, and general services are performed on the first floor. The entrance lobby is quite spacious and the large show cases, leased by the better stores, enhance its appearance and are a source of great interest to the ladies.

Vertical transportation for customers is by means of two automatic elevators having a speed of 250 fpm. An enclosed manlift is used by the operating personnel. Certain floors have been framed to accommodate escalators should they become necessary but to date the elevators have handled capacity patronage with ease and dispatch.



Nine-story garage in San Francisco, with 1,200 stalls, is seen under construction. Formwork is being erected for pouring of circular entrance and exit ramps. Note use of Sonotubes for pouring columns. Reinforcing for pylon can be seen in center.

Before construction of the new building, about 90 percent of the site was covered by Type 3 store and hotel buildings varying in height from one story and basement to six stories and basement. All exterior walls were supported on the foundations of still older buildings erected before the earthquake and fire which destroyed a large part of the city in 1906. All such foundations were of plain concrete construction extending up to first floor level and at adjoining lot lines had a thickness of more than 4 ft.

Since the existing basement retaining walls at the curb line on the two street fronts were found in good condition and adequate for their purpose, they were incorporated into the new structure. Every remaining vestige of the old buildings was removed before the new construction began.

Subsoils were explored by drilling test borings of 5-in. diameter, employing wash-boring equipment, to a depth of approximately 50 ft below the basement floor. With the exception of relatively thin strata of brown sandy clay and brown sandy clay loam encountered at a depth of from 20 to 30 ft below the basement floor, the borings produced, as expected, nothing but yellowish brown medium sand, and it is on this material that the foundations rest. Unit soil pressures used for the foundation were in accordance with the recommendations of Dames and Moore, the soil engineers, and varied from a maximum of 7,000 psf for wide footings to a minimum of 4,000 psf for narrow

footings for dead plus live load. Live load on suspended slabs, 75 psf, was cut to 45 psf on all columns and footings. Lateral forces due to earthquake varied from floor to floor, with a maximum of 0.06 × (dead load + 0.6 live load) in the first story.

Round columns in the body of the building are spaced 26 ft 6 in. on centers east and west and 25 ft 0 in. on centers north and south. Each bay accommodates two cars parked on 45-deg diagonals in standard 8-ft × 18-ft stalls. One-way traffic aisles are 15 ft wide. Exterior columns on the two street fronts are placed 9 ft back from the building lines and the floor slabs cantilever out from there 11 ft, including a 2-ft "eyebrow" extending beyond the street line. The two street-line elevations have open fronts.

Solid reinforced concrete bearing walls run the full length of the interior north and west lot lines, for the full height from foundation to roof. Except for three fireproofed steel girders carrying columns over the ramps in the entrance, the building is entirely of reinforced concrete construction.

Suspended floors are flat-slab type designed on the basis of Presan photo reflective stress anaylsis, with tapered haunches in place of the usual drop panels and column caps. This type of construction yielded a considerable saving in concrete and form work. Ensuing savings over a conventional flat-slab design are conservatively estimated as follows:

Slabs	$47,124.00
Columns	2,100.00
Walls	18,195.00
Footings, excavation, etc.	2,500.00
Total	$69,919.00

In addition there was some reduction in reinforcement, and there was a 6-ft reduction in the total height of the building—about 12 in. per story. The savings due to these items were not easily determined and are not included in the above total.

Why pylon was chosen

A rectangular building with a wall along one side and one end only would not be a stable structure under earthquake action, and such a building, without additional elements, would be subjected to enormous torsional moments which could produce serious results. The situation was further complicated by the fact that the rear and side walls of the building are in contact with adjacent buildings so that any serious movement might damage these structures as well as the garage itself.

First thoughts were turned toward utilizing the columns as resisting elements. However, shear in the columns would induce serious moments, which in turn must be carried by the adjacent slab, thus requiring heavy additional reinforcement for both columns and slabs. Furthermore, the flexibility of the columns for such a high building would result in serious lateral deflections under earthquake action.

Several ideas, which are discussed later, were investigated and abandoned as being either impractical, too costly, or too cumbersome. Finally a reinforced-concrete pylon, prestressed for the lower 40 ft, was adopted. This pylon is located on the north-south axis of the ramp and extends the full diameter between the inner lines of the inner ramp and the full height of the building. It proved to be a simple, practical solution and one that did not require the loss of any car stalls.

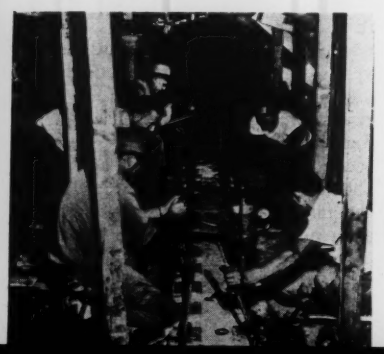
The pylon as built has an I-beam plan (Fig. 1) with the following dimensions: overall north and south length, 36 ft 9 in.; flanges, 6 ft 0 in. × 6 ft 0 in.; web thickness, 2 ft 0 in. Stressteel reinforcement is placed in the prestressed part of the pylon, which extends from the foundation to the third floor. There are 49 bars of 1 1/8-in. diameter in each flange, and 48 bars of the same diameter in the web. See Fig. 1. Intermediate-grade reinforcement, used above the third floor, varies. In the flanges, it varies from 49 No. 11 bars in the third story to 16 No. 11 bars in the top story; in the web it varies from 24 No. 9 bars in the third story to 24 No. 7 bars in the top story. The pylon foundation, 40 ft 0 in. × 72 ft 0 in., with an average thickness of 7 ft 0 in., contains 750 cu yd of concrete which was placed and consolidated in six working hours. The pylon foundation is reinforced with 37 tons of intermediate-grade bars in top and bottom and in both directions, of proper size and spacing to accommodate the bending moments.

The design of the pylon was based on the use of 4,000-psi concrete in the prestressed part, from the foundation to the third floor, but actually 5,000-psi concrete was poured in this part of the work. Above the third floor, 4,000-psi concrete was used, and this type was also used in the main building columns up to the fifth floor. All other concrete in the structure was of the 2,500-psi variety. These are 28-day strengths. All concrete contained an admixture of Tricosal.

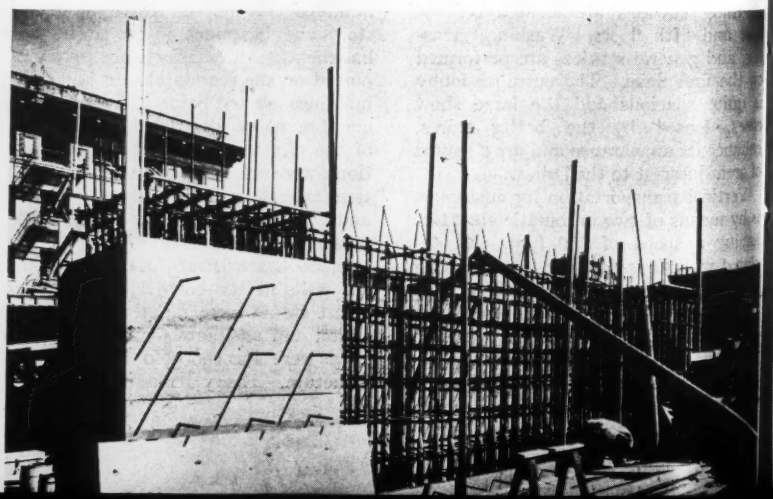
Pylon carries large horizontal force

To picture the magnitude of the problem, it is necessary to know that the entire building weighs approximately 60,000 kips. The seismic coefficient specified by the San Francisco Building Code is 6 percent of gravity for a ten-story building. Hence the total hor-

Tension is placed in Stressteel bars at third floor. Remaining height of pylon is conventional reinforced concrete. Inspector (upper center) checks elongation of bars at both jacks. Prestressing, performed by two crews, cut deflection at top of pylon to ½ in. Without prestressing for height of first three floors, deflection would have been 1½ in.



Reusable 5/8-in. plywood panels form concrete. Here formwork for fifth lift of pylon is being erected. Couplings for Stressteel bars can be seen along lower edge of lift.



izontal force to be designed for is 0.06 × 60,000 = 3,600 kips, acting in any direction.

As is usual in designing for lateral forces, the rigid concrete slabs in all the floors are assumed to act as horizontal diaphragms transmitting shears and moments in the horizontal plane. The relative stiffness of the columns is very slight and offers little resistance, so that lateral forces are carried solely by the pylon and the walls on the interior lot lines. Under these conditions, the force of an earthquake in the north-south direction will be divided between the pylon and the west wall. Since the pylon is nearer to the center of the mass of the building than the west wall, it will carry 62 percent of any earthquake force in this direction. In the east-west direction, the pylon is quite flexible and offers practically no resistance to earthquake forces. Hence any earthquake in that direction will act eccentrically on the north wall, thus producing a torsion in the horizontal plane. That torsion, transmitted through the slab, is resisted by a couple formed by the west wall and the pylon. Thus an east-west earthquake will also exert a force on the pylon in the north-south direction, of about 30 percent of the total lateral force in this case.

The maximum lateral force will be exerted on the pylon when an earthquake occurs at an angle of about 26 deg with the north-south axis, and as much as 68 percent of the total earthquake force will be carried by the pylon in that case. Thus the pylon is designed for a lateral force of 68 percent × 3,600, or approximately 2,400 kips applied to it at the floors. The pylon is actually a vertical cantilever of 100-ft span carrying the horizontal loading above mentioned. In accordance with the requirements of the Building Code, the

All interior surfaces except floors are painted white. Note tapered drop heads at columns.

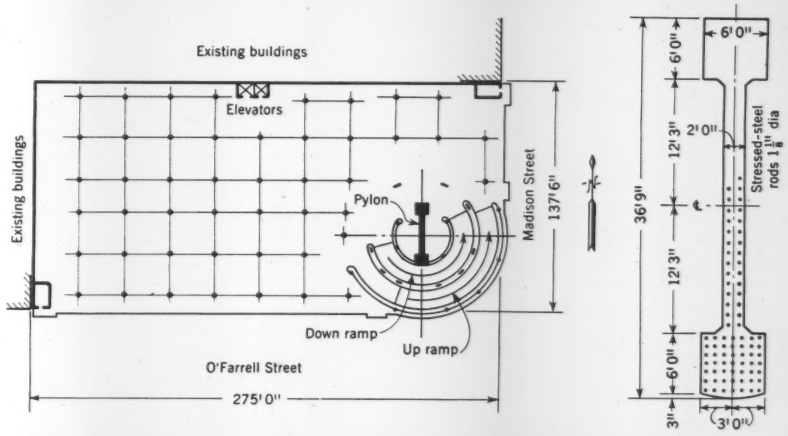
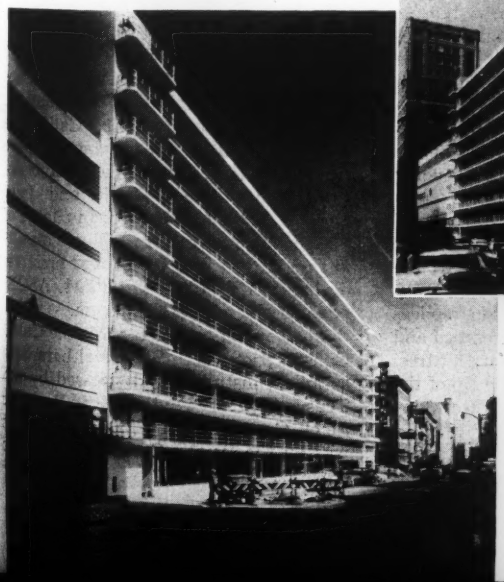


FIG. 1. Typical floor plan, at left, shows location of 100-ft-high pylon at center of concentric ramps. Area occupied is 137 ft 6 in. × 275 ft 0 in. Horizontal accelerations due to earthquake forces are taken by pylon and north and west walls. Concrete floor plates are assumed to act as horizontal diaphragms to transmit shears and moments in horizontal plane. At right is pylon section below third floor. It contains total of 146 Stressteel reinforcing rods, 49 in each flange, and 48 in web.



San Francisco's new self-service parking garage cost only 63.56 cents per cu ft, or $1,875 per car stall. Structure is flat plate design with circular columns. Access is by circular ramps, at far corner of left view.

lateral force per floor is greatest at the top floor, diminishing gradually toward the basement. Hence the maximum bending moment at the base of the pylon is 148,000 ft-kips. This moment acts either towards the north or the south, thus producing a complete reversal in direction during an earthquake.

In view of the importance of the pylon design, several alternatives were considered. The first was a vertical steel truss which necessitated members up to 200 sq in. in cross section. Such a truss would have to be fireproofed with concrete and not only would be too expensive, but would result in excessive horizontal deflection at the upper floors. The second alternate was a reinforced concrete truss. This would be somewhat more rigid and less expensive, but secondary stresses could not be handled economically.

The third alternative was a reinforced concrete pylon, not prestressed. This required a steel area of 430 sq in. at the base, diminishing toward the top. The computed deflection of the pylon unfortunately was still too high. Under the design earthquake forces, the maximum deflection at the top of the pylon would be about 1.5 in. This would result in appreciable moments in many columns and would necessitate a large amount of additional reinforcement in them in the adjacent slab.

Prestressing to reduce deflection

To reduce the pylon deflection, the possibility of prestressing was then investigated. By prestressing vertically, the concrete can be put under compression at all times so that the entire section of the pylon concrete can be effective in resisting deflection. The major part of the deflection was caused by bending in the lower part of the vertical cantilever. Hence by prestressing only the lower 40 ft of the pylon, the deflection at the top could be reduced to 0.5 in. With this amount of total deflection in ten stories, the moments induced in the columns can be carried without additional steel reinforcement, thus resulting in a worthwhile economy not otherwise possible. The cost of the pylon itself, however, was not reduced by prestressing.

The amount of prestress required was determined by the condition that no tensile stress would exist in the pylon under the action of earthquake forces. Thus:

Stress due to moment of 148,000 ft-kips	± 925 psi
Stress due to weight of pylon	− 104 psi
Stress due to weight of tributary floors	− 52 psi
Stress due to prestress	− 769 psi
Resulting maximum stress	−1,850 psi

Since a one-third increase in allowable stresses is permitted for lateral forces, the normal permissible stress of 1,800 psi can be increased to 2,400 psi for 4,000-psi concrete. Hence the maximum stress of 1,850 psi is quite safe. The factor of safety against cracking was determined by considering the modulus of rupture of concrete at $0.15\,f'_c$ or 600 psi. Then

$$\text{Factor of safety} = \frac{925 + 600}{925} = 1.65$$

which indicates that the concrete will not begin to crack until the design earthquake force is exceeded by 65 percent and acting in the worst possible direction. Because of the margin of safety reserved in the structure so designed, it was deemed unnecessary to bond the prestressing steel to the concrete, although it would have further increased the ultimate strength.

To resist lateral forces without tension in concrete it is necessary to prestress the entire concrete area to 769 psi. This requires a total force of 13,300 kips, which can be supplied by either high tensile wires, strands, or bars. Since the steel has to be erected vertically, the use of either wires or strands would require additional scaffolding. Hence Stressteel bars were selected for use. To further simplify the erection, the 47-ft bars were ordered in five lengths, the bars being spliced at each pour height of about 10 ft. These bars are manufactured with tapered threads so as to develop approximately 98 percent of their full strength at splices and end anchorages. With the 1 1/8-in. bars stressed to an initial value of 110 kips per sq in. (ksi), a final effective prestress of 95 ksi can be attained. A total of 146 bars was employed in the pylon section.

Maximum principal tensile stress occurs at the junction of the flange and the web and is computed to be 140 psi under the design earthquake force. This corresponds to $0.035\,f'_c$ and is allowable. Stirrups are provided in the web to give additional resistance against such tension, and mild steel bars spaced around the exterior faces of the pylon serve as shrinkage and spacing bars. Although the maximum prestress was required only for the base of the pylon, the same amount of steel is used for the entire lower 40 ft. At the junction of the prestressed and nonprestressed part of the pylon, splices are provided between the Stressteel and the ordinary reinforcing bars. Stressteel couplings are used at the tip of the prestressing bars, and dowels 6 ft long are connected to the couplings.

Except for interior columns, all formwork in contact with concrete was Douglas fir plywood, (EXT-DFPA) concrete form grade, 5/8 in. thick, especially constructed for re-use. Forms for interior columns were Sonotubes.

Wall formwork was removed not earlier than four full days after completion of the pour. Slab formwork was removed 21 days after pouring and was reshored to the second floor below for a further period of seven days. Sonotubes remained in place until a time convenient for their removal.

All concrete above the first-floor level was raised by means of hoists, dumped into hoppers, distributed by buggies, and consolidated by mechanical internal vibrators.

Floor slabs were integrally finished by a two-course application of A. C. Horn Company's Dust-on, then power floated, steel troweled, and cured by covering with a layer of sealed Sisalkraft. Finish on sidewalks, the entire first floor (except the lobby) and the ramp from the first to the second floor, was integrally colored.

The finish flooring in wash rooms is ceramic tile; in lobby and offices, asphalt tile. The roof covering is Laykold emulsified asphalt.

As the two street fronts are completely open for the full height of the building, mechanical ventilation is required only for the basement. Exhaust fumes enter the underground concrete ducts through vents flush with the floor and are discharged above the roof level. Only the basement is equipped with an automatic sprinkler system. All floors have fluorescent lighting and all interior surfaces throughout, except floors, are painted white. The building was erected, ready for use, in 230 working days.

A few cost figures

The total cost of the building, exclusive of filling station equipment was $2,250,000. This comes to $1,875.00 per car stall, $5.38 per sq ft of floor area, or 63.56 cents per cu ft of building.

The owner is the Downtown Center Corporation, Dr. Ferd W. Callison, President. The architect was George A. Applegarth, of San Francisco, Calif. The consulting structural engineers were Ellison & King, also of San Francisco, for whom John K. Rode and John Cherno, A.M. ASCE, were in charge of design and supervision. The consultant on earthquake forces and prestress design was Prof. T. Y. Lin, M. ASCE, of the University of California.

The general contractor was the Cahill Construction Co.. Stressteel bars were supplied, installed, and stressed by the Truscon Steel Division of Republic Steel Corporation. Flat-slab analysis was by the Presan Corporation, of Los Angeles, Calif.

Junior Member energy

—a Society asset

ROBERT M. OLSON, J.M. ASCE, Consulting Engineer, Houston, Tex.

During the years since the grade of Junior was established in the American Society of Civil Engineers, increasing consideration has been given to the problems of the professional man in this grade. Symposiums have been conducted, polls have been taken, statistics have been tabulated, conferences have been held in an attempt to properly define the problems of Junior Members.

Fundamentally his problems are similar to those of all young men. Specifically they are the problems of educated, highly trained technical men who are seeking their place in an established profession. Within this profession certain benefits accrue to the individual engineer which are not available in the other professions. On the other hand, he finds certain problems of professional status in his own society, in the overall profession of engineering, and in the relationship between himself as a professional man and the layman.

With the aggressiveness, ambition, and impatience of youth he is anxious to get into the swing of things—now. He realizes that recognition of his effort and ability will come with time but he feels that he can make a certain contribution to the recognition of the entire Society and profession if he can actively participate in professional activities—now.

American history has been characterized by rapid expansion with respect to geography, economics, and population. Within our Society a corresponding expansion has taken place. Gail A. Hathaway, in his presidential address at the 1951 Summer Convention (ASCE TRANSACTIONS, Vol. 116, p. 1475), highlighted that expansion and noted that,

"The most important factor in the Society's growth within recent years has been the significant increase in the number of Junior Members . . . .

"As the proportion of Junior Membership to the total has progressively increased to the present ratio of approximately 50 percent, the average age of the composite membership has become correspondingly lower and the interests and needs of the majority have been changed appreciably by this trend."

I should like to consider this increase in Junior Members in a metaphorical sense as a source of useful energy to increase professional recognition of the individual member and the entire Society.

Although physicists today are primarily concerned with the theories of relativity and quantum mechanics, I should like to reflect for a moment on an older, more familiar theory, the kinetic theory of matter. "According to this theory a gas is a congregation of an enormous number of particles, or molecules, moving in all directions, colliding with each other and changing in directions of motion with each collision." (*The Evolution of Physics*, by Albert Einstein and Leopold Infeld, Simon & Schuster, Inc., New York.) Let us for the moment consider our profession as analogous to this phenomenon. Our membership is the "enormous number of particles" and the moving and colliding is the activity of the membership.

Returning to the kinetic theory of gases, we learn from *College Physics*, by C. E. Mendenhall, A. S. Eve, D. A. Keys, and R. M. Sutton (D. C. Heath & Co., Boston), that "after an encounter between two molecules, each may bounce away from the other, but in general not with the same individual speeds which they had before impact. A very fast molecule would on the average be slowed down, a very slow one speeded up." Again we can draw the analogy that through the "impacts" of the leaders and the Junior Members the activity of the entire membership is changed. This might better be explained by considering the concept of "mean free path." If we traced the motion of an individual molecule, it would be made up of a series of straight jumps, called free paths, between successive impacts, and if we could measure a large number of these and take the average, it would be the mean free path for the gas under the given conditions. Thus the average professional activity of our membership is a function of the "impacts" created by the individual professional activity of the members.

Returning to our gas (and to *The Evolution of Physics* previously mentioned), we know that there exists an average speed of the molecules. "There will therefore be an average kinetic energy per particle." It follows that if we increase the number of molecular particles we will increase the heat, with

a corresponding increase in the average kinetic energy of the particles and a greater pressure on the containing vessel.

A comparable situation exists in our Society. We have increased the Junior membership and we have increased the energy available to exert pressure on our Society and our Code of Ethics. These have been well designed to withstand the pressure created by the professional activities of our membership.

It is within the framework of the Society and its Code of Ethics that the Junior Member can find the solution to his problem. This conference is an indication that we are thinking about, and working at, solutions. This conference is a part of a continuing process sponsored by our Society to advance the professional recognition of the Junior Member and to increase the professional recognition of the entire membership. Our Society possesses an immense source of energy in its individual members which, if properly applied in all grades of membership, will yield greater benefits to the profession and to the public.

In his 1951 address, then-President Hathaway also stated,

> "Most of these Junior Members are salaried employees and the majority are destined to remain in this classification throughout their careers. The report of the Engineers Joint Council on the 1946 survey of the engineering profession, entitled "The Engineering Profession in Transition," contains data showing that the classification of workers in the Civil Engineering Profession is slightly more than 86 percent employee . . . ."

Typical problems of Junior Members

Let's consider some typical problems of these Junior Member, employee-engineers. The Junior Member who seeks recognition for his effort and ability and who is an employee-engineer is subject to the policies of his employer. Sometimes these policies allow for participation in technical society activities—sometimes they do not. The Junior Member looks to the Society, and the Code of Ethics as his guide in seeking recognition, and looks to his employer for a favorable atmosphere in which to develop his individual capacities. If his employer or immediate supervisor is a member of the Society, the Junior Member may go to him with this problem, thus creating a pressure on our Society and Code of Ethics as interpreted, consciously or unconsciously, by the individuals concerned.

The Junior Member may wish to participate in some activities of the Society such as the Daniel W. Mead contest. He may find recognition from his employer or supervisor—he may not. It is an individual problem. Its solution will contribute to the composite recognition of our membership.

Or again, the Junior Member may have been considering a problem of a technical nature. He may take his ideas to his employer or supervisor. His efforts may be recognized—they may not. It is an individual problem. Its solution will contribute to the composite recognition of our membership.

Or, a situation may arise where the Junior Member wishes to attend a function of our Society. His request may meet with approval—it may not. It is an individual problem. Its solution will contribute to the composite recognition of our membership.

Or, the Junior Member may have a scholarly bent. He may approach his employer or supervisor seeking recognition for his ability, and exploring the possibility of doing part-time study at the graduate level. His effort may meet with approval—it may not. It is an individual problem. Its solution will contribute to the composite recognition of our membership.

Or, the Junior Member desiring to improve his standard of living may go to his employer or supervisor seeking an increase in salary. He may believe that recognition of his particular effort and ability should be indicated by a salary increase. He may find that the policies of his employer allow for such recognition—they may not. It is an individual problem. Its solution will contribute to the composite recognition of our membership.

Or, the Junior Member may have particular ability in executing work. When a position as junior executive or administrative assistant becomes open, his ability may be recognized—it may not. It is an individual problem. Its solution will contribute to the composite recognition of our membership.

Or, the Junior Member may go to his employer or supervisor seeking recognition for effort spent on his own time in some civic, community, or cultural project and asking for time during working hours for the further pursuit of this activity. His request may be granted—it may not. It is an individual problem. Its solution will contribute to the composite recognition of our membership.

Or, where the policy of a company is to share profits or ownership with its employees, a Junior Member may go to his employer or supervisor with the proposition that the engineering personnel should share in such profits or ownership on a special basis. This suggestion may be favorably received—it may not. It is an individual problem. Its solution will contribute to the composite recognition of our membership.

These are a few hypothetical problems. Most of these and similar problems are solved on the basis of past experience, existing policies, and an understanding between the individuals concerned on the particular problem when it arises. Such solutions—now—are the past experience of tomorrow; the guide to future policies, and the basis of greater understanding among civil engineers.

Let's return for a final look at our kinetic theory. Assuming that a vessel has been so designed as to withstand pressure, it is of little value unless it is applied to produce some desired result. The conditions of the gas can be varied, thus yielding a different result.

In our analogy we too can vary the conditions to produce a desired result. We, as Junior Members, should not avoid "impacts" with our elders, but should attempt rather to use these "impacts" to produce individual recognition so that the composite recognition will be increased. The older members by actively working to solve these individual problems within the framework of Society policy and the Code of Ethics and through cooperation with the Junior Members, can add to the composite recognition.

In our consideration of intra-Society relationships we have disregarded pressure from outside sources. The result of such pressure can be as negligible as that of outside pressure on a vessel unless the pressure within the vessel is allowed to drop too low.

Through proper utilization of the pressures created within our membership, the composite recognition produced will allow for greater recognition of the individual Junior Member—now.

(This address was originally presented by Mr. Olson at the ASCE Annual Convention, before the Conditions of Practice Session, presided over by Jewell M. Garrelts, Chairman, Committee on Junior Members.)

JOHN P. H. PERRY, M. ASEC

Vice President, U.S. Lift Slab Corporation, New York, N. Y.

Office building of 370,000 sq ft erected by Lift Slab method

One of the largest buildings to be erected in this country by the Lift Slab method is nearing completion. This is an office building to house personnel of five Ford Motor Company manufacturing divisions at the company's River Rouge plant in Dearborn, Mich. The structure has three stories with a total floor area of approximately 370,000 sq ft, and when fully occupied is expected to house 2,500 people. It will be fully air conditioned.

The first footing was poured on July 8, 1954, and pouring of floor slabs began on September 12. The first slab was lifted on November 20, and the last on January 11. A portion of the building will be completed early in June, and a second wing will be ready for occupancy in October.

This structure well illustrates the essential features of the Lift Slab method of erecting reinforced concrete buildings. These features are relatively simple. The floor and roof slabs are designed as for flat-slab construction, two-way reinforced, except that there is no flaring or enlargement of the column head or drop panel. Instead there is a steel casting called a lifting collar, which is designed to take the shearing stresses between the column and the slab. Columns usually are of steel of various shapes. They may be round (usually heavy steel pipe), or wide-flange sections, or built up of stitch-welded angles, or angle-and-plate box columns. The round or square columns sometimes are concrete filled.

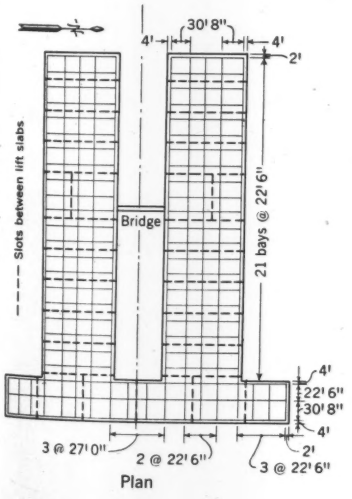
Occasionally the columns are of reinforced concrete or prestressed reinforced concrete, either round or square. Columns are designed as free standing (cantilevers, in effect) with extra-large bearing plates and extra-large connections bolted to the footings. The top of the footings and the bearing plates are kept lower than is customary on concrete buildings poured in place. In the case of the Ford office building, the columns are wide-flange sections, spaced from 22 ft 6 in. to 30 ft 8 in. on centers, as shown in Fig. 1. The lifting collar is shown in Fig. 2.

In the erection of a Lift Slab job such as this, it is customary to design the steel columns so that they project at least 1 in. above the top of the final position of the roof slab to leave room to mount the lifting jacks. When the jacks are removed, this extra inch is burned off before the roofing is placed.

All the steel columns were fireproofed with metal lath, with 1 in. of Perlite plaster, and with the usual steel corner beads. However, the under side of the lifting collars, an area outside the finished dimension of the column, perhaps 6 in. wide all around, was not fireproofed. It is however possible on Lift Slab jobs to cover this collar by recessing it for 1 in. so that the exposed steel surface can be fireproofed with vermiculite or similar material.

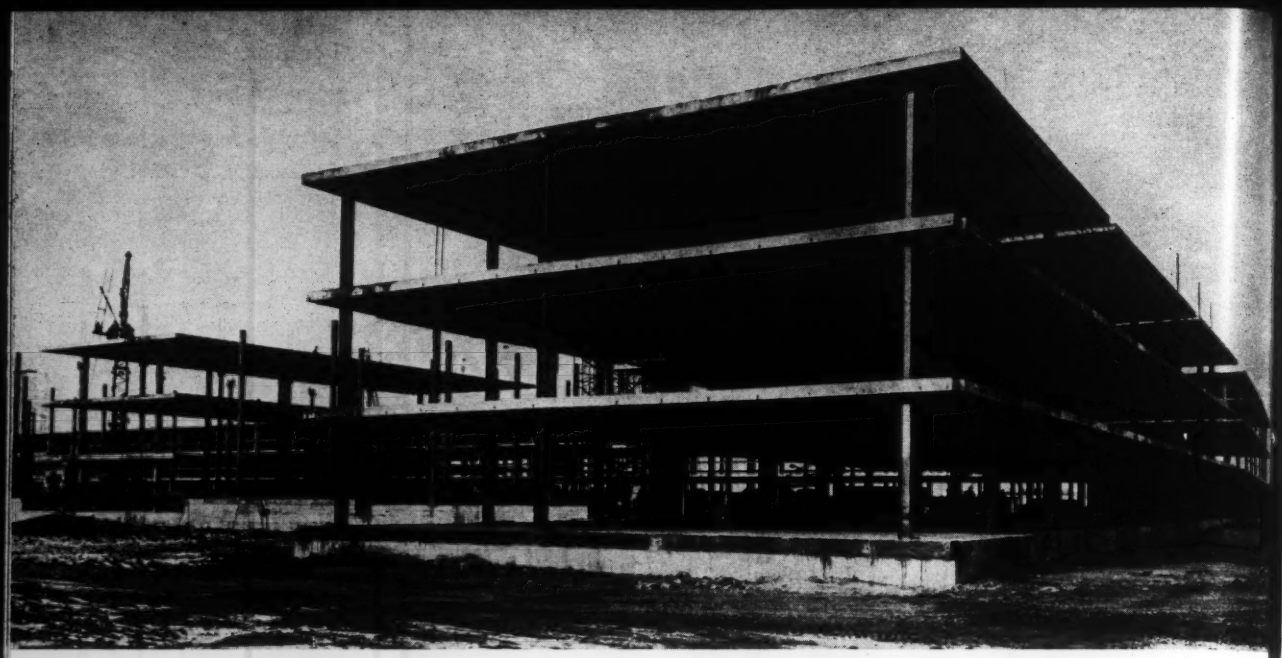
While not generally customary on Lift Slab jobs, on this building all parties agreed to take the precaution of using temporary I-beams to brace the tops of all columns before the roof slab was lifted. These I-beam braces were placed just below the jacks and just above the roof slab. They were removed when the roof slab was securely in place and used again on each succeeding section of the building.

It is usually desirable on buildings to be erected by the Lift Slab method to take advantage of continuity in the



Plan

FIG. 1. Floor plan of Ford Motor Company office building is in shape of double T, with column spacing as shown. Lifting was accomplished in 28 sections for each of three slabs—second floor, third floor, and roof. New equipment, not then available, would have reduced number of sections lifted by 50 percent.



All slabs are seen lifted into position on front section. Lifting was accomplished in sections varying from 2,570 to 4,750 sq ft, on 10 or 12 jacks. Note slots between sections, later to be poured in place.

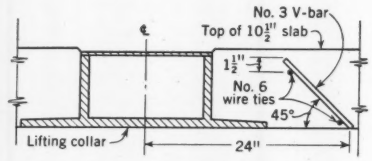
slabs by having the exterior rows of columns set back from the exterior building walls for about one-third of the span. In any event the exterior line of columns must be kept back from the edge of the slab a minimum of 12 in. so that the lifting-collar plate will be encased in concrete. On the Ford office building the exterior columns are set back 4 ft from the face of the building, and 2 ft at the ends.

To be suitable for erection by the Lift Slab method, buildings should have the major openings through the floor slabs in the middle strips. This would be true on any flat-slab design, because openings should interfere a minimum with the column bands of reinforcing steel. On the Ford Rouge building, the designer located his elevator, stair wells, and part of his mechanical risers in half a column bay and then framed this half bay with the usual beam and girders of poured-in-place concrete on conventional wooden forms and shores.

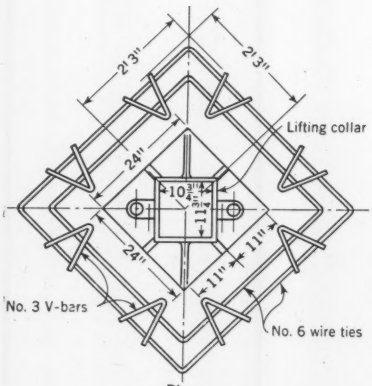
A comparison between the Lift Slab method and the ordinary forming method from the point of view of safety is very dramatic. An accurate comparison can be drawn between the Ford building, containing 370,000 sq ft of floor space, and a nationally prominent structure of comparable size being erected simultaneously by means of forms by the same general contractor. Over a ten-month period the Lift Slab project had a loss ratio (that is, accident cost divided by insurance cost) of only 8 percent, while the formed concrete project had a loss ratio of 37 percent when it had reached the same stage of completion. Considering hidden costs not disclosed in a comparison such as this, based on insurance premiums, the Ford office building came out even better. The frequency and severity of accidents have been dramatically less on this project, thus facilitating handling of both men and materials, besides saving time.

In the early stages of construction, the Ford project somewhat resembled a forest of columns rising from what appeared to be an overly thick ground-floor slab. This thick slab was in reality made up of four separate slabs not unlike a stack of buckwheat cakes. Instead of maple syrup between the cakes, however, in this case there was a bond-breaking compound of emulsion which kept the slabs from sticking together.

The sequence of fabrication required



Cross section



Plan

FIG. 2. At head of column, additional shear resistance was required on this building. Lifting collar, even with reinforcing steel welded to it, was considered insufficient. Two (and sometimes four) circumferential rings of No. 6 wire were therefore added, together with No. 3 V-bar reinforcement. Photo shows lifting collar embedded in raised concrete slab and welded in place on shear plate. Note how shear plate is used to develop strength of connection.

that the ground-floor slab be placed first and trowled to a granolithic finish. This steel-trowel finish served as the bottom form for the next slab, and so on for succeeding slabs. Buildings erected by the Lift Slab method have gone as high as seven floors, topped off, of course, by a roof slab. Since the top of each succeeding slab has the same carefully troweled finish, the under side of the slab poured on it is also smooth, so that no surface treatment is required on the ceilings.

After the last slab in the pancake stack had been poured and allowed to cure until it had reached about three-quarters of the design strength, the lifting operation began. In the case of the Ford building, the criterion was a 2,500-psi test strength for a 3,000-psi design strength. Each slab was lifted into position by means of hydraulic jacks fitted to the top of the columns. The roof slab was of course lifted first, followed by the slab for the top floor and then in order those for the floors below.

Because of the large floor area involved, the floor was divided into sections each containing about 4,500 sq ft and lifted by a set of jacks (either 10 or 12). This division into sections is the customary procedure wherever the floor area is greater than can be conveniently lifted by a set of 12 jacks. New lifting equipment and techniques now make possible 20-column lifts from a single console, or operation of multiple consoles to make a single lift on 36 columns.

Between adjacent sections a slot or channel about 3 ft wide was left open. The slots were ultimately filled by the conventional method of putting up a form with shores under it and pouring the concrete in place.

These slots serve several purposes:

1. They permit the economical use of a set of jacks, which are controlled by a console, or control panel, similar to the console from which great organs are played. By means of this console the rate of movement of each jack in a set is synchronized and controlled.

2. They give a certain amount of flexibility to the structural frame of the building so that, before the last welding is done and the slots filled, the building can be plumbed as is customary on a structural steel building.

3. They permit lapping of the steel reinforcement in the two-way bands, the lap being the usual 40 diameters.

4. The slots also provide for continuity either by sleeves or welding of conduits or pipes which have been buried in the floor slabs.

5. Any irregularities in the relative levels of the lifted sections can be remedied when the slots are poured.

6. The slots also allow the stresses caused by deflection and shrinkage, common to all concrete buildings, to be dissipated without causing damage.

One of the early problems in erecting Lift Slab buildings was to secure inserts in an immovable position before the slabs were concreted. In the conventional reinforced concrete building the inserts can be tacked to the wooden forms. The problem was satisfactorily solved at River Rouge by welding the inserts to the reinforcing bars, the only method so far devised for solving this problem using Lift Slab. This method has the added advantage of providing a positive connection, because the reinforcing bars are partly welded to the lifting collars and all reinforcing is securely tied in place.

Openings through the slab for pipe risers were boxed out the same as on a conventionally poured concrete building. As is customary in Lift Slab buildings, a sleeve was provided in the first-floor slab long enough to rise through all the slabs—four in this case. Accuracy was very easily checked because the vertical sleeves were fastened directly to each other.

The designer of the Ford building had to familiarize himself with the sequence in which certain parts of the building would come into focus. This applies also to the major subcontractors. As on all Lift Slab projects, coordination in the early stages of the project between the designer, owner, general contractor, and major subcontractors was necessary to attain the principal asset of the method, that is, high speed of erection.

Construction sequence

Each slab was prepared in the following sequence after the columns had been erected and plumbed: (1) The lifting collars were "strung" on the columns; (2) the lower layer of reinforcement was placed in position; (3) the subcontractors laid the conduit and pipes which had to be buried in the concrete and placed all inserts (welding the latter to the reinforcing); (4) the top mat of reinforcing was placed, and the reinforcing bars in both bottom and top layers were welded to the steel lifting collars; (5) the concrete was poured in place using Pumpcrete; (6) the concrete was steel troweled to a hard finish; (7) as soon as this surface was reasonably well set up, the first of the coats of bond-breaking compound was applied (on this job Techkote No. 400 Y-S was used); (8) two days later, just before the next slab was poured, a second coat of bond-breaking compound was applied. Immediately after this final step, the next cycle of construction was started, that is, the preparation of the second-floor slab, which was placed directly on top of the completed first-floor slab. Steps 2 to 8, as listed above, were repeated for each succeeding slab.

As each slab was lifted into its approximate final position, a crew of certified welders connected the steel shear blocks to the columns. These shear blocks are about 4 × 8 in. by about 1 to 1½ in. thick, depending on the stresses involved. When the first-pass welds were completed on all ten columns, in about 100 minutes, the floor or roof slab was lowered to final position with the lifting collars coming to rest on top of the shear blocks. See Fig. 2. Later, as time allowed, the second welding operation was completed. This consisted of the second pass, and the welding of the steel lifting collars to the top of the shear blocks. In some cases the top of the lifting collar was welded to the column at the top of the finished floor slab.

The time involved from the start of the last slab until this slab was lifted into place and welded, was about 15 calendar days. This was during the late fall and early winter.

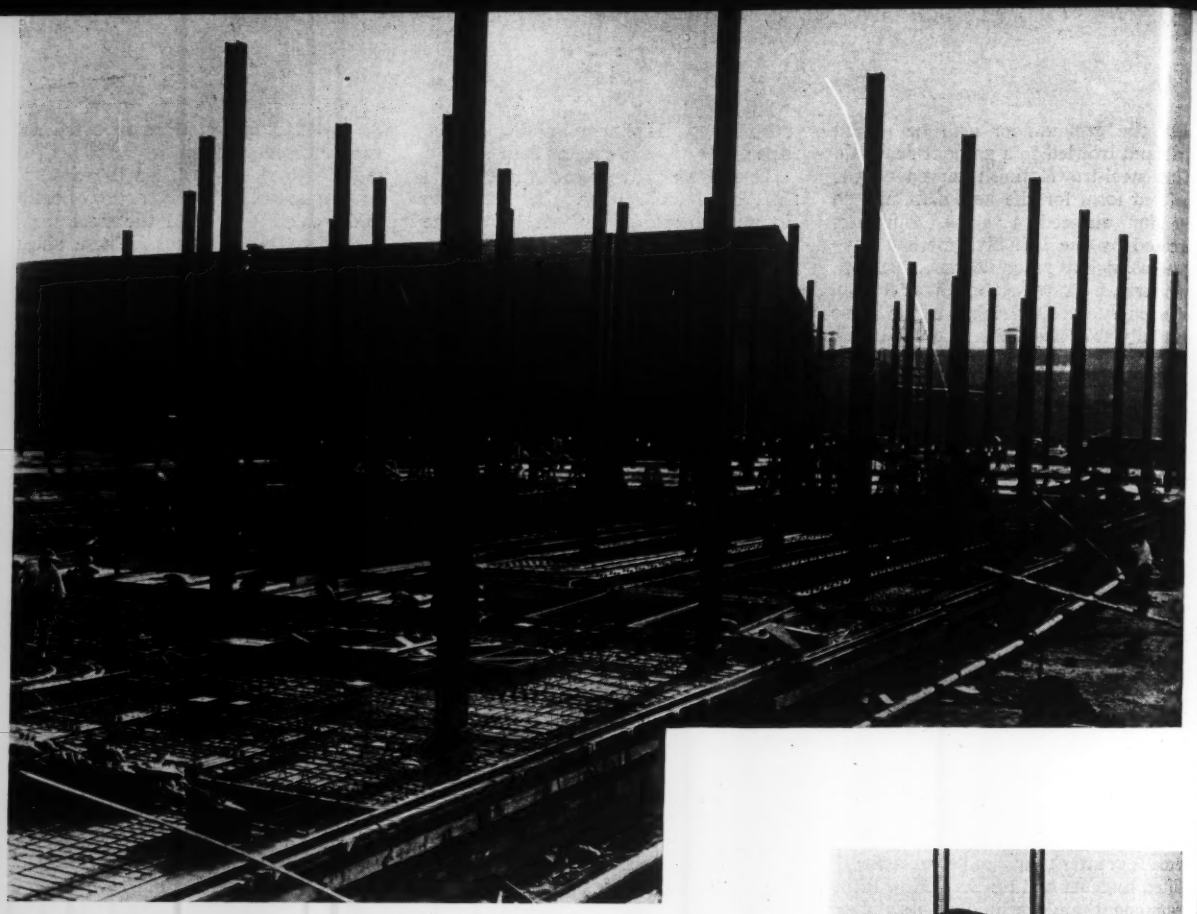
The construction cycle used in the erection of the structural frame of a building by Lift Slab requires only 50 to 60 percent of the time needed for conventional poured-in-place concrete construction. This time saving is due to a number of factors other than the slab lifting process itself. The vacuum process used on all slabs at the River Rouge plant removed excess water and shortened the time required for the finishing operation. Also, the ultimate strength of the concrete was attained faster than in normal pouring of concrete. The use of Pumpcrete for concrete placement also speeded up the job. Another important factor was that 95 percent of the concrete was poured at ground level.

The general contractor on this job estimated that approximately 5 months were saved from start to occupancy over the time required by conventional methods, or about 33 percent. It is significant that only about 20 carpenters were used, whereas about 200 would have been required for conventional building methods.

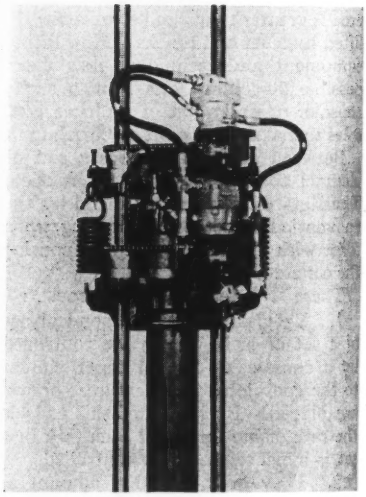
During the 15-week period from the middle of September 1954 to early January 1955, a total of 400,000 sq ft of slab was fabricated and put in place—an average weekly production of 26,000 sq ft. The general contractor states that on an even larger building he was erecting in Kansas City by the conventional method of poured-in-place concrete, he was able to place only 13,200 sq ft of floor per week.

Design standards

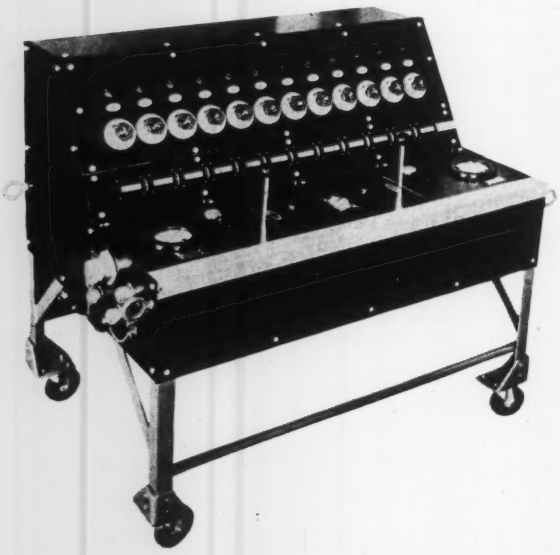
The standard design now generally followed for Lift Slab work in this country is that of the American Concrete Institute for flat-slab reinforced concrete



On wide-flange steel columns, lifting collars for third floor and roof are pinned temporarily in place. Reinforcing steel for second floor is ready for concreting, on top of first-floor slab, previously poured. Roof and floor slabs are generally $10^1/_2$ in. thick. Reinforcing for floor slabs runs under 5 psf, and for roof slab, under 4 psf.



Slab is lifted by hydraulic jack here seen on round column. During lifting, upper nuts remain stationary as piston head moved upward. Synchronized lower nuts turn as threaded lifting bars move up. At end of stroke, spring retracts piston head while lower nuts hold bars (and hence slab below) in position. Upper nuts move down with piston head. Nuts are operated by electric motor. On Ford office building, 10 (and sometimes 12) jacks were used in group to move one section of slab. Each jack weighs about 700 lb. Movement of all jacks in group is synchronized by console, at left.



construction. Flat-slab design, with its balanced moments, provides a maximum of continuity. This requires no panels or special framing for stairwells or other openings. Any floor openings are formed prior to pouring of the slab and the resulting structural problems are solved by adequate reinforcing. Flat slabs to be erected by the Lift Slab method are more economical when the column spacing is from 20 to 25 ft. This spacing may be increased to 50 ft if the resulting flat plate is of waffle slab design. Waffle slab is now being built using three different types of forms—either light sheet metal, plastic, or treated cardboard.

Dead-load settlement must be taken into consideration when tying panels, girders, columns, and slab together. With the Lift Slab method, all dead-load settlement takes place as soon as any one slab is clear of the slab below. In solid slabs, as distinct from the waffle slabs used with wider column spacing, the problem of dead-load settlement is solved by giving the slab a camber. This is done generally by placing the concrete screeds so as to provide the desired camber in the first floor poured on grade. Succeeding slabs then receive this camber automatically.

Some items more expensive

One of the items of expense which offsets the apparent economy of the Lift Slab method is the fact that the columns must normally be of steel instead of the reinforced concrete commonly used in buildings erected by the conventional method. On the Ford project the cost of the 10-in. wide-flange columns erected in place was $265 per column or $7.50 per lin ft of column. This figure includes the base plates and the bolts which secure them to the footings. Another item of expense, and an important one, is the cast-steel lifting collars. On this job the lifting collars were 24 in. square, weighed approximately 175 lb each, and cost 7.5 cents per sq ft of floor.

Actually the subcontract cost of lifting the slabs, welding the shear blocks in the columns, and welding the lifting collars to the shear blocks, was 30 cents per sq ft of floor.

The Long Construction Company reports that the average form and lifting cost on this job was 48 cents per sq ft, compared to 75 cents per sq ft on a similar structure the company was building at the same time in Kansas City by the conventional poured-in-place method. This difference of 27 cents per sq ft, or a saving of about 40 percent, does not include the additional savings effected by working at ground level, or the substantial saving to owner and contractor made possible by the reduction in overall time of completion of the building. Also this saving does not include the labor rate differential in forming cost, which amounts to 11 cents per sq ft in the Detroit area.

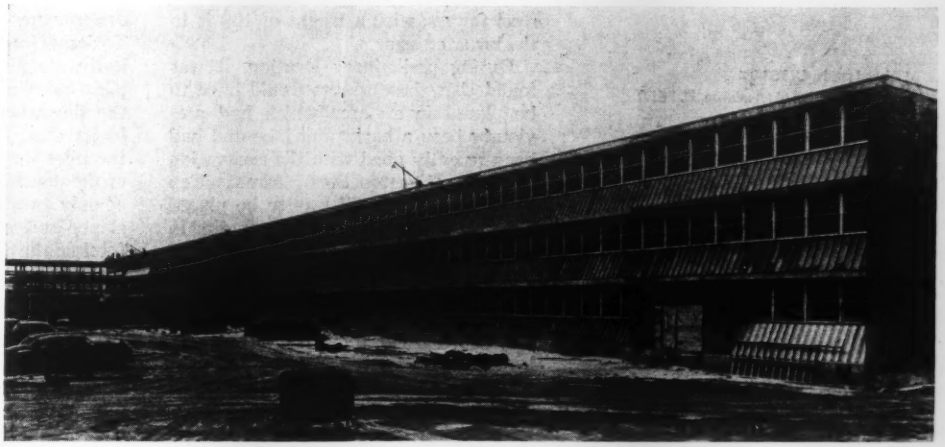
Another factor yielding savings in cost and in the use of labor is the fact that material-hoist towers are largely done away with or are reduced in size and number, since equipment and material can be hoisted on the slabs. When subcontractors—particularly plumbers, steam fitters, electricians, sprinkler men, and sash and partition subcontractors—get used to working on buildings being erected by the Lift Slab method, they take advantage of the opportunity to place their heavy materials on the slab just before it is lifted into permanent position. There is real economy in this arrangement.

On the Ford office building, no crawl space was specified under the first floor although pipe tunnels were provided. Such space is sometimes required in buildings built by Lift Slab. When a crawl space is required, the customary method is to pour the first slab on the ground as usual. Then, after the roof and the slabs for the upper floors have been lifted into final position, the first-floor slab is lifted up the necessary 3 or 4 ft to provide the crawl space.

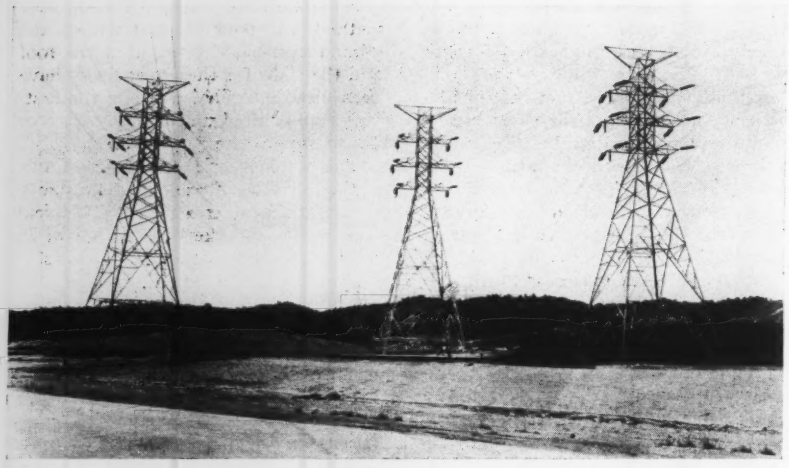
The simplicity of the structural frame of the building afforded great flexibility in architectural treatment. This feature has been taken advantage of in most Lift Slab structures. Flat-slab floors also afford a reduction in the overall building height. The elimination of column capitals and drop panels helps to solve many architectural and mechanical problems. The method also provides maximum use of prefabricated materials, particularly in walls and partitions.

On the Ford office building, the general contractor estimates that the saving effected by the Lift Slab method was 5 percent of the total cost of the building (exclusive of the cost of air conditioning) as compared to the price he would have charged for erection by the conventional poured-in-place method.

The Youtz-Slick basic patents under which this building was erected, are owned by the U.S. Lift Slab Corporation of Austin, Tex., and New York, N.Y. These patents have been on the market about 5 years. In that period the company has issued 19 licenses—14 in the United States, 3 in Canada, 1 in Puerto Rico, and 1 in Iceland. On this Ford job the lifting and welding was done by the Skyhook Lift Slab Corporation of Kansas City, which is owned by the general contractor, the Long Construction Company, also of Kansas City. The general contract eventually covered the mechanical subcontracts for plumbing, heating, lighting, sprinklers, elevators, and air conditioning. The architect-engineer was Eberle M. Smith Associates, of Detroit.



Exterior wall consists of insulated aluminum skin used instead of masonry. View is from northwest. Story height is 10 ft 10½ in.



Three transmission towers (seen from Kingston Steam Plant) have foundations placed on 35 ft of loose fill, with vertical and battered piles carried to rock.

Battered piles

for economical tower foundations

GENE M. WILHOITE, A.M. ASCE

Civil Engineer, Tennessee Valley Authority, Chattanooga, Tenn.

Three heavy-angle and dead-end electric transmission towers recently installed adjacent to the Tennessee Valley Authority's Kingston Steam Plant, near Harriman, Tenn., presented an interesting foundation problem. These three structures are located approximately 500 ft from the Kingston Steam Plant switchyard. Each tower is designed to support two three-phase 154,000-volt circuits, of 795,000-circular mill A.C.S.R. (aluminum conductor, steel reinforced) conductors, and two high-strength steel ground wires of $^{7}/_{16}$-in. diameter. The structures themselves are conventional double-circuit steel towers, with a height of 108 ft to the lower cross arm.

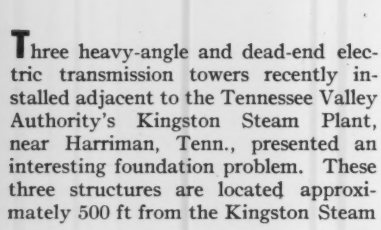

Finished grade, El. 750.0±
Top of foundation, El. 751.0
1952 grade, El. 740.0
Loose sandy clay soil
Loose saturated sandy clay soil, subject to periodic saturation
Original natural grade, El. 715.0
Shale rock, El. 705.0
Compact sand, inorganic silt soil

FIG. 1. At tower location, shale rock was 46 ft below top of foundation, and intervening materials were unstable except for bottom 10 ft.

During preliminary location, it was found that these towers would have to be placed in an area which had previously been a backwater lake and had been recently filled with the excavation from the Kingston Steam Plant. Ten additional feet of fill was to be placed over this area to complete the grading in the vicinity of the plant. See Fig. 1.

Unstable soil calls for piles

Because of the unstable condition of this soil, caused by a combination of loose fill and periodic saturation, it was not feasible to support the towers with only reinforced concrete foundations. Since there are three towers, a total of twelve footings was involved. As the wire arrangements on the towers may be changed in the future, it was necessary to design all footings to carry the same loadings.

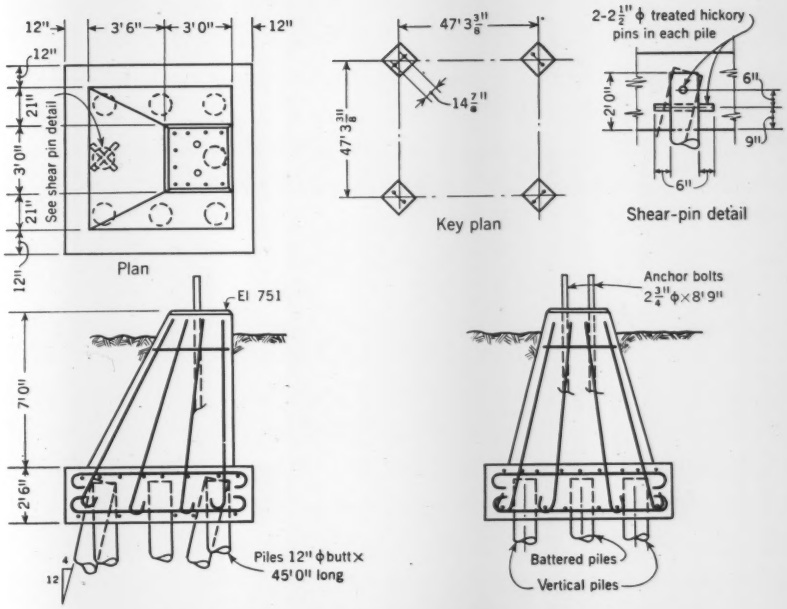
The towers required a footing which could withstand a load combination of downthrust plus horizontal shear, or uplift plus horizontal shear. To transmit these loads to a stable medium, a timber pile support of pressure-treated piles was considered to be the most economical solution. Since the piles would be subjected to a variable ground-water level, they had to be pressure treated with creosote and capped with masonry if installation was to be considered permanent. A working load of 4 kips laterally on the top of each pile was allowed, based on available test experience on timber piles. This load, when applied to each pile of a pile cluster, in soil of this type, will not produce excessive displacement.

The reinforced concrete cap, or pier (Fig. 2), above the cutoff point of the piles, serves three purposes: to transfer the loads to the pile cluster, to seal the butt end of the piles, and to allow the piles to be cut off at a reasonable distance below the ground line. The pier is sloped on three faces to resist the moment of the shear loads and to allow sufficient area for the base, or pile cap, so that the piles could be spaced a minimum of 2 ft 6 in. on centers. This spacing allows the piles to function properly for the design loads and gives driving clearances. The reinforced concrete foundation is basically in two parts—the shaft, which transfers the loads from the tower into the reinforced concrete mat; and the mat, which distributes these loads to the piles.

Battered piles take shear loads

The first idea was to use only vertical piles, but because of the horizontal shear loads, this would have required a minimum of 10 timber piles for each footing, and a correspondingly larger concrete cap to cover the top of the pile cluster. To design for this condition more economically, the increased value of battered piles for shear loads was utilized. As the downthrust load and shears were larger than the uplift load and shears, the piles were battered in the direction of the downthrust shear. With the use of only two piles battered on a 4-to-12 slope, and six vertical piles for each footing, the allowable working shear of 4 kips per pile was not exceeded. Preliminary selection was made following conventional methods of pile analysis, and the final design was checked by A. Hrennikoff's displacement analysis. A graphic picture of the resulting axial and lateral loads on the eight piles in each footing is given in Fig. 3.

FIG. 2. Plan and cross sections in two directions give details of reinforced concrete pier and pile spacing.



Since the design of these footings was based on certain assumptions as to the type of soil that would be encountered, close coordination was maintained with the field forces during construction to verify these assumptions. The holes were opened to a depth of approximately 8 ft, or to the bottom elevation of the concrete piers. The soil down to a depth of 7 ft was comparatively stable and showed no evidence of water seepage, but below this level seepage into the holes was very rapid. The holes had to be shored up and pumped to keep them drained.

Driving verifies assumptions

In driving the piles, the penetration verified the original assumptions as to the soil encountered. When the initial weight of the driving hammer was placed on the heads of the piles they sank roughly 12 in. From this point to the old original natural grade, El. 715, fairly rapid penetration was obtained on all the piles. Below this level, and for a depth of from 8 to 10 ft, the soil stiffened and penetration dropped off very rapidly, showing that compact soil had been reached. Below this point, additional driving indicated that penetration had been made to the shale rock deposit.

After each cluster of eight piles had been driven to refusal, each pile was tested with additional blows to check that there had been no rebound while adjacent piles were being driven. All pile clusters were symmetrical, and the battered piles maintained their level without difficulty. As the piles had been obtained with additional length, the butt which was damaged by driving was well above the cutoff point. After preparation of the piles, the reinforced concrete caps and piers were placed to complete the foundations. Tower erection followed soon after, and with the stringing of the conductors, the lines from Kingston were ready for service on schedule.

The design work was carried out by the writer under the direction of R. F. Connelly and A. H. Spotswood of Civil Engineering Branch; and tower and foundation construction by the Power Construction Branch with H. O. Murphy in charge; both Branches of TVA's Power Engineering and Construction Division at Chattanooga, Tenn. The piles were driven by TVA's Knoxville Division of Construction located at the Kingston Steam Plant.

Typical excavation for a footing pier shows six vertical piles already driven and cut off and first battered pile being driven. Note high water level and muck in hole.

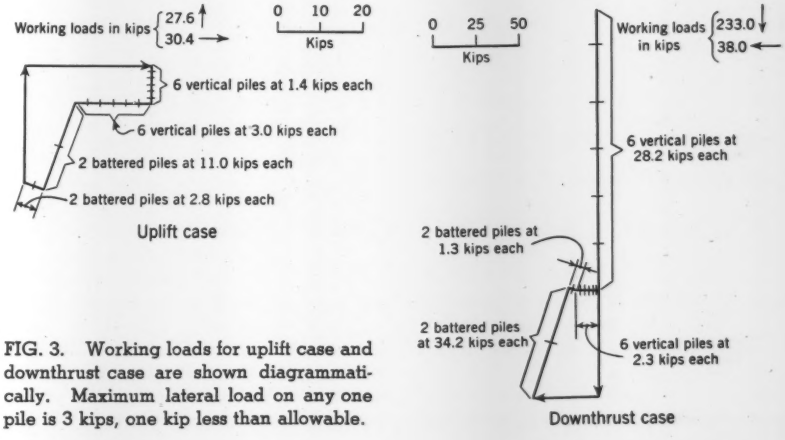

Working loads in kips
27.6
30.4
0 10 20
Kips
6 vertical piles at 1.4 kips each
6 vertical piles at 3.0 kips each
2 battered piles at 11.0 kips each
2 battered piles at 2.8 kips each
Uplift case
0 25 50
Kips
Working loads in kips
233.0
38.0
6 vertical piles at 28.2 kips each
2 battered piles at 1.3 kips each
2 battered piles at 34.2 kips each
6 vertical piles at 2.3 kips each
Downthrust case

FIG. 3. Working loads for uplift case and downthrust case are shown diagrammatically. Maximum lateral load on any one pile is 3 kips, one kip less than allowable.

MEXICO'S PALACE OF FINE ARTS

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In 1950 the authors' firms were engaged by the Mexican Government to make an investigation of the causes and the amount of the settlement of the Palace of Fine Arts (Palacio de Bellas Artes); to study the feasibility of methods by which the Palace could be returned to its original level; and to prepare an estimate of the cost of doing the work. The investigation showed that to return the building to street level immediately would be possible but exceedingly costly and, in the long run, self-defeating. The following resumé of the results of the investigation adds to our professional knowledge of a foundation condition not duplicated elsewhere in the world. Except for minor patching, no corrective work on the structure is being undertaken.

SETTLES 10 FT

Can it be stopped?

One of the most important buildings in the City of Mexico because of its architectural beauty is the Palace of Fine Arts. It is also one of the most expensive in Mexico. World attention has been directed to it because of the 10-ft settlement it has undergone—a movement which is continuing at the rate of 1.5 in. per year in relation to the streets outside the "influence bowl" of which the Palace is the center.

Construction of the building was begun in 1904 following the design and plans of Adamo Boari, an Italian engineer. Because of a number of interruptions in the work, some for long periods of time, it was not finished until thirty years later, in 1934.

The Palace consists of a structural steel frame with its entire exterior facade surfaced with Italian Carrara marble. Interior partitions are of brick. Most of the superstructure load is carried through the steel columns to the foundation mat. This concrete mat, from 6 to 10 ft thick, is heavily reinforced, with grillages consisting of 24-in. I-beams running between column bases and with 15-in. I-beams at right angles to them. See Figs. 1 and 2.

In plan the building is approximately rectangular with overall dimensions of 267 by 390 ft. It weighs 57,500 tons. Its concrete foundation mat extends 5 ft beyond the exterior walls on all sides except on the south, where it extends about 60 ft beyond the building line. The weight of the mat is about 46,000 tons.

From the records it appears that concrete for the foundation mat was placed in at least two lifts. Unreinforced concrete to a thickness of about 4 ft was poured in the finished excavation; the steel reinforcing grillages were then installed; and finally, additional concrete was poured around the grillages to finish the mat.

During the initial pouring of the mat, a subsidence in the center was noted. Although lightweight porous volcanic rock was substituted for normal aggregate in the final pouring of certain sections of the mat, the subsidence continued. Records of a survey of the surface of the mat made in 1907 show that it had taken a noticeably dished shape, the center being 1.5 in. lower than the ends. By 1908 the mat and that part of the building already constructed had settled 5.5 ft, and during 1910 a crack appeared in the surface of the mat extending from northwest to southeast.

All Mexico City Settles

The City of Mexico has presented foundation difficulties since its earliest recorded history. It lies in a wide, flat valley surrounded by high mountains, at an elevation of approximately 7,400 ft above sea level. No major rivers enter the valley. However, in the past the rainfall and runoff from the surrounding mountains have been sufficient to keep the ground-water level at or very near the surface throughout the entire section of the valley covered by the city. In the seventeenth century a tunnel was driven through the eastern mountains to drain out sewage and other waste water. This water loss, in combination with greatly increased pumping in the past few years, has seriously lowered the ground-water levels in the subsoil throughout the area.

Originally the entire Valley of Mexico was occupied by a lake surrounded by active volcanoes. Fine ashes discharged from these volcanoes settled slowly to the lake bottom, where they formed a spongy, highly compressible material with a very high water content—sometimes as high as 500 or 600 percent of the weight of the solids.

Lowering of the ground-water levels is causing a general settlement of the surface over the entire city. The present rate of settlement, approximately 12 to 15 in. per year, may well increase if continually increasing amounts of water are removed from the soil in the Valley of Mexico.

If this general subsidence were the only settlement occurring at the site of the Palace of Fine Arts there would be no problem because the whole city (with the exception of buildings on piles) would be settling at a more or less uniform rate. However, since its construction, the Palace has been settling at a greater rate than the surrounding streets and buildings. This settlement has now exceeded 10 ft below the surrounding area, so that the Palace is down in a bowl-shaped sunken area, greatly reducing its architectural effect. Another difficulty is that, as the building has settled, the two porticoes on the east and west sides, being considerably lighter than the main section, have not settled as much as the main building, causing heavy cracking and unsightly tilting of steps and terraces.

Although the settlements are very unsightly, in themselves they are not considered dangerous to the structure of the building. However, a differential settlement of much greater importance is beginning to take place.

Early attempts to halt settlement

During construction several steps were taken in an attempt to halt the settlements of the Palace. First, a wall of interlocking steel sheetpiles was driven around the entire perimeter of the building at a distance of approximately 10 ft from the edges of the mat. It is assumed that this sheetpiling was driven in the belief that the soil under the Palace was being displaced hori-

zontally, causing a "mud wave." This idea, however, is entirely incorrect, since the settlement of the Palace is not due to horizontal movement of the subsoil but to a consolidation of the soil as the water is squeezed out of it. Settlement of the building continued unaltered in spite of the sheetpiling.

It was noted next that the northern end of the building was settling at a greater rate than the southern end, probably because of the weight of the theater and stage equipment installed in the northern part of the building, and because the heavy dome on the southern end had not yet been added. Beginning in 1910 an attempt was made to consolidate the soil under the north end of the mat by injecting cement grout into it. Between 1910 and 1913 a grout mixture containing approximately 70,000 bags of cement was pumped under the mat in the form of grout. Exploratory borings made during this investigation showed that the grout was being deposited erratically in lenses at various locations and depths. The subsoil is too fine grained to permit uniform distribution of grout. Although the settlement decreased temporarily, according to the records available, it is probable that more harm than good was done by adding many tons of cement grout to the already heavy load on the subsoil.

Present rate of settlement measured

As part of the 1950 investigation, accurate records of the settlement of the Palace and of the entire area around it were made.

Borings made in connection with the building of foundations for a 44-story office building erected by La Latino Americana adjacent to the Palace indicated the presence of two sand-bearing layers, one at a depth of about 100 ft below the surface, the other about 174 ft below it (Fig. 1). Since it would not be economically feasible to carry any underpinning work below the 174-ft level, all the level work was based on a series of bench marks carried to this level. The lower sand layer is also settling in relation to the surrounding mountains, but for foundation work such settlement is comparatively slow.

The primary bench mark was installed in the southeast corner of Alameda Park, diagonally across the street from the Palace. All leveling was referenced to this point. One other bench mark based on the lower sand stratum was installed outside the Palace at the northwest corner, and one was installed through the mat inside the Palace. Five more reference points were based on the first sand stratum (105 ft below the surface). Four of these are outside of the building, near its corners, and one is inside the building through the mat adjacent to the bench mark driven to the lower sand stratum.

All bench marks were installed in a similar manner. First, a wash boring was put down to the top of the layer on which the bench mark was to rest. Into this hole a pipe, closed at the bottom, was inserted and then driven to refusal with a drop hammer weighing 145 lb. The tops of all bench-mark pipes are capped, and in the center of each cap there is a small raised metal disk on which to rest the level rod.

A total of 223 surface level points were carefully established on the Palace, on the sidewalks and streets adjoining it, and in the adjacent Alameda Park. In the park, 50 points were established on 82-ft centers each way. All the other points are located on the Palace or on the streets and sidewalks adjoining it. Weekly level readings were taken on these points.

Results of the leveling survey showed that the average rate of settlement of the building exceeds that of the surrounding areas of the city, and that the settlement of the Palace is causing a general subsidence in the form of a bowl-shaped area surrounding it. This "influence bowl" of which the Palace is the center, is settling at the rate of 1.5 in. per year faster than the area outside the "bowl." With relation to the sand layer at the 105-ft depth, the Palace and its "influence bowl" are settling at the rate of nearly 5 in. per year.

Feasibility of underpinning

To underpin a structure as large and heavy as the Palace would require a stratum of good load-carrying capacity to which transfer of load could be made. At least a dozen buildings 10 to 22

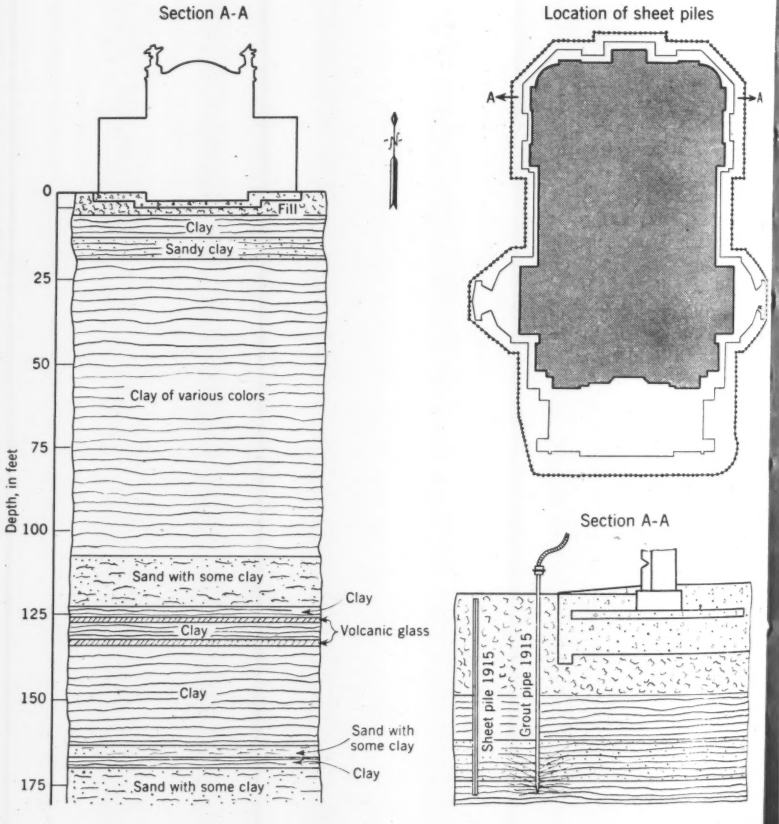
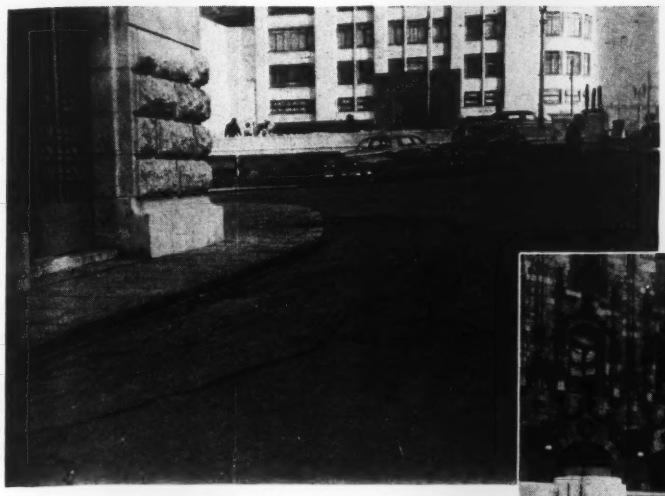
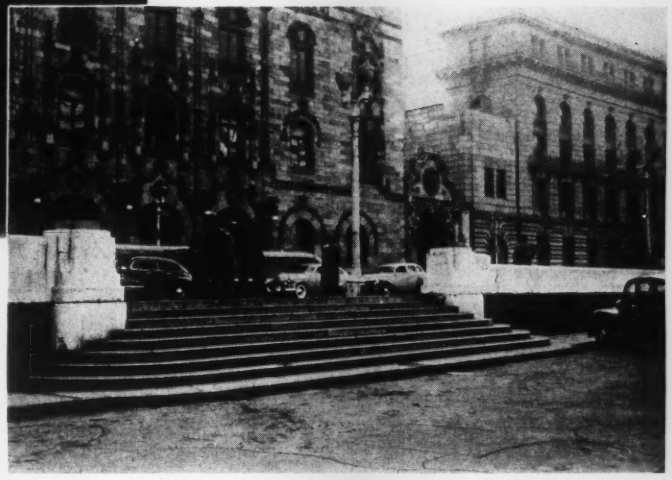
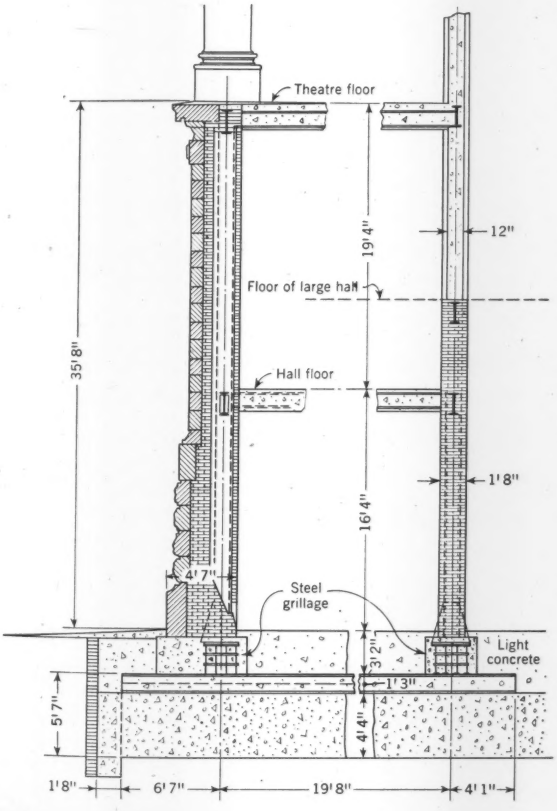


FIG. 1. Palace of Fine Arts in Mexico City is outlined in plan, above right. Thin line marks edge of concrete mat on which building rests. Outer line indicates sheetpiling driven in 1915 during construction of building, in effort to halt settlement. Cross section at left gives composition of underlying strata, as determined in 1950 investigation.





Building and its "influence bowl" are settling 1.5 in. per year faster than surrounding streets, and now rest in depression 10 ft below street level. Northeast corner of Palace, looking north, is seen in view above. Flight of steps in right-hand view leads up to street level from east entrance of Palace.



Porticoes on east and west sides, being much lighter than main building, have settled less and are tipping upward.

FIG. 2. Section through one bay of Palace shows details of building as constructed according to design of Adamo Boari, Italian engineer.

Primary bench mark was installed in corner of Alameda Park, diagonally across street from Palace. This bench mark, carried to 174-ft sand stratum, is shown as it appeared in 1950 (below) and in 1955 (in photo at right).

Bench marks placed through concrete mat inside building go down, one to 100-ft sand layer, the other to 174-ft sand layer. Lower sand layer is settling much more slowly than upper sand layer.

stories in height have been safely carried on wood piles with point diameters of 8 to 10 in., driven to the sand stratum 105 ft down, each pile carrying 25 tons. The two buildings so supported adjacent to the Palace have "risen" more than 2 ft in relation to the surrounding streets and sidewalks. This shows that the 105-ft stratum is carrying the building load plus the friction load of the subsiding clay. At one time the piles also sustained the suction and friction loads caused by the separation of the structure from the contacting soil.

The possibility of carrying the underpinning piles for the Palace through the 105-ft sand stratum to bearing on the lower stratum at the 174-ft depth was examined. If this were done, aside from the obvious economic considerations, the Palace would "grow" about 13 in. per year, and in 15 years would be so far above the ground surface that it would have to be lowered—an extremely expensive procedure.

It was determined, therefore, that if the Palace is to be successfully underpinned, the piles should be carried to the top of the 105-ft layer of sand. A forecast of the movement of the Palace after underpinning was made by combining computations of the probable deflection of the 105-ft sand stratum under the load of the structure with the observed rate of settlement of adjacent areas. In about 3 years the structure would begin to "rise"; in 10 years the rise would be about 20 in.; in 20 years, 50 in.; in 40 years the top of the mat would again be level with the surrounding streets; in 50 years, it would be 24 in. above the streets.

A strong indication that a reversal of stresses is taking place in the foundation mat is that the mat is not cutting into the ground immediately adjacent to it. Cracks have appeared in the Palace structure which will certainly increase if the differential settlement increases.

Method of underpinning recommended

After careful study, the best solution for underpinning the Palace appeared to be to install concrete-filled steel pipe through the mat to the 105-ft stratum. The piles would carry design loads of 90 to 110 tons each. Based on a 100-ton load per pile, 950 piles approximately 105 ft long would be required, so spaced that their center of gravity would coincide approximately with the center of gravity of the loads of the building. Installation would be by jacking the pipe piles down in sections to a final resistance of 125 percent of design load. Each pile would be constructed so that it would transmit no load to the mat until all the piles were in place. After all the piles were in place they would be quickly, and nearly simultaneously, locked into the mat in such a manner that each connection would develop twice the design load on the pile.

The cost of underpinning the Palace of Fine Arts to halt its settlement and to return it slowly (in 40 years) to its original position with relation to the surrounding ground was estimated to be $1,535,000 (U.S. dollars).

Because of the high rate of surface settlement of Mexico City, if the building were jacked up to its original level at once, at a roughly estimated cost of $2,000,000 (U.S. dollars), it would be necessary to lower it again in a few years at an additional cost of $1,150,000 (U.S. dollars). This procedure is clearly impractical and not economically feasible.

The complete report, which is contained in a book almost 1 in. thick, was submitted to Lic. Miguel Aleman, President of Mexico, and Lic. Manuel Gual Vidal, Secretary of the Ministry of Public Education in the fall of 1950.

Although nothing further has been done to date, this report clearly established, for the first time, that the continued settlement of this building, second only in renown to the Leaning Tower of Pisa; could be safely arrested —and at a cost far below that anticipated by many of the engineers who had studied this fascinating problem (including the initial estimates of the companies making the study).

FIELD STATION

Fourth article in a series sponsored by ASCE Hydraulics Division's Committee on Research

supplements hydraulic facilities of University of California

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To supplement existing campus facilities of the University of California for instruction and research, and for cooperative research with outside agencies or individuals, the Department of Engineering Field Station, at Richmond, Calif., approximately 7 miles from the Berkeley campus, was activated in 1950. The area, comprising 108 acres, some 60 buildings, and facilitating services, is administered by the Department of Engineering. Service to industry is administered through the Institute of Engineering Research. The hydraulic facilities, administered by the Division of Mechanical Engineering, consist of a combination wave and towing tank, a river model area, a model basin, and pump testing facilities.

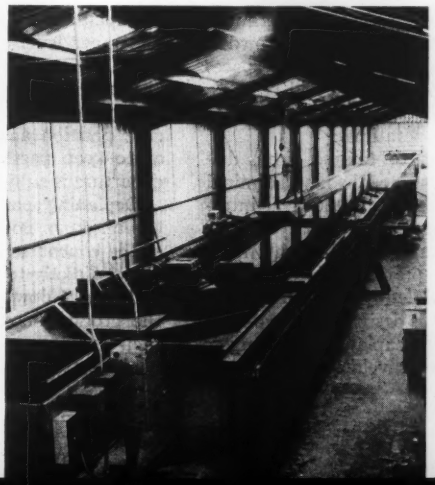
The combination wave and towing tank, 8 ft × 200 ft × 6 ft deep, as shown in an accompanying photo, is provided with two window sections for photographic purposes. An aluminum tow car which spans the tank is cable actuated in either direction, with a total pulling force of 150 lb. The cable drive, connected to a two-speed gear box, is driven by an electronic amplidyne, Ward Leonard system. Speed range of the car is from 0.5 to 20 fps, and it can be accelerated to maximum speed in 15 ft. Car speed is measured by an electronic counter and timer. A bulkhead-type wave machine, at one end of the tank, is connected to a belt-driven gear box and powered by a variable-speed motor. Waves with a period of from 0.4 to 5.0 sec, and amplitudes of from zero to 34 in., can be produced. Amplitude can be varied during operation.

In the river model area, the initial basic unit consists of a reinforced concrete slab 40 ft × 120 ft, with sumps and trenchways. Three trenches divide the area into four sections and provide for return flow to the main sump, space for water and other service lines, and provisions for sediment catch basins. Total gross working volume of the sump and trenchways is 2,700 cu ft. Incorporated in the slab are supports for a 3-ft × 3-ft × 100-ft metal flume, adjustable from level to a 5-percent slope, and provided with a 15-cfs pump, driven by a variable-speed motor. Several pumps and a head tank provide water for the river model area.

The model basin, shown in a photograph, is 64 ft × 150 ft × 2.5 ft deep and has a nominal working volume of 19,000 cu ft. Removable wood bulkhead sections positioned around the basin permit incorporation of such appurtenant features as may be required. Water in the basin is gravity drained for reuse to the adjoining storage basin, and returned by pump. A combination photographic and working platform spans the basin and, with camera boom, provides complete coverage of the basin for most of the working range of from 10 to 35 ft above the water surface. A flap-type wave machine generates waves for the entire basin width, and is sectionalized to be used in 20-ft elements. A bulkhead-type wave machine is scheduled for construction this year.

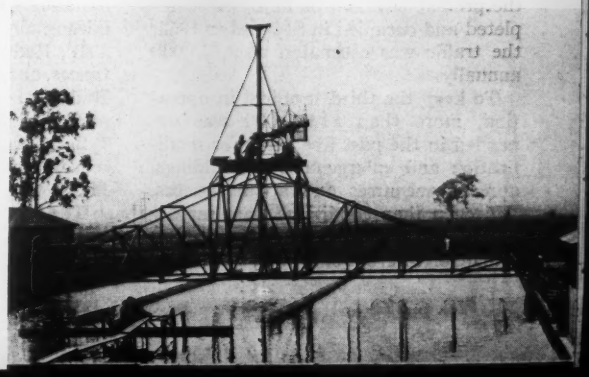
Pump testing facilities consist primarily of three basins, each with a working capacity of approximately 4,000 cu ft, a concrete slab area, and a 40-ft × 48-ft general test building. The recirculation basin includes a pump test pit 8 ft × 8 ft × 17 ft deep, provided with crane facilities. The volumetric basin, for measuring discharge, adjoins the recirculation basin and is provided with basic members to support decking and equipment. The make-up basin at slab elevation, common to both basins, is provided with openings to permit installation of automatic gravity-flow control equipment to maintain water levels in the recirculation basin. Existing equipment includes a 50-hp vertical-reaction thrust dynamometer, electrical meters, and a series of flow meters up to 16-in. pipe size.

In current investigations, the combination wave and towing tank is being used to determine mooring cable forces as a function of waves, dynamics of floating drilling structures, and hydrodynamics of ship structures. Studies of wave refraction on sloping beaches are being conducted in the model basin; and investigations of the viscous boundary sublayer along a smooth wall, and the influence of unrelated frictional effects on sediment transport, in the river model area.



Combination wave and towing tank is equipped with wave machine and electrical drive (foreground) and tow car and drive (center).

Model basin is spanned by photographic crane. Note secondary training walls and one section of wave machine, positioned to left.



Passengers enplane from concourses of new Terminal Building, here seen from front. Concourse C is wing-like structure extending out from main building to right, and Concourse D to left. Air Mail and Cargo Building is flat structure which appears behind right shoulder of main Terminal Building.

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Air terminal building features two-level operation

That a straight line is the shortest distance between two points is a fact not lost on the designers of the new terminal at San Francisco International Airport. The terminal layout is so arranged as to permit flow of passenger traffic directly from surface transport to airplane. To further speed passenger flow, enplaning traffic is handled on a separate floor from deplaning traffic. This plan, besides convenience for the traveler, offers maximum passenger capacity for the given terminal area.

San Francisco International Airport is now occupying its fourth Terminal Building since it opened for traffic in 1927, the previous buildings having become successively inadequate as a result of increased traffic. The first terminal building was constructed before the opening of the airport, the second in 1935. The third, opened in 1938, was designed when the total number of revenue passengers in and out annually was about 75,000. It was designed to accommodate a maximum of 575,000 passengers in and out annually. Before the present terminal building was completed and occupied in September 1954, the traffic was estimated at 2,645,000 annually.

To keep the third terminal in operation, more than $1,000,000 was expended in the past five years for modification and enlargement of buildings, apron, concourses and appurtenances, and even then conditions were rapidly becoming intolerable. A separate terminal for international flights was also established during this period to reduce the congestion at the main terminal. During 1955, passenger traffic will probably reach the 3,000,000 figure for which the new Terminal Building was designed.

The new terminal has been planned so as to permit expansion to accommodate 10,000,000 passengers a year plus associated baggage, mail, express and cargo. Actually it can handle 5,000,000 passengers without substantial alterations. The design is such that each part can be expanded individually as increased traffic and patronage may require. When traffic rises above 10,000,000, it is expected that new runways will be required. The staff of the San Francisco Public Utilities Commission is now planning for this expansion of runways and landing facilities.

Economies effected

Occupancy of the new Terminal Building, besides alleviating crowded conditions for passengers, apron space, automobile parking, cargo and baggage handling, permitted the following economies in airline operations:

1. Reduction of taxiing time, distances, and costs since the new Terminal Building is centrally located near intersection of perpendicular runways.
2. Concentration of all flights from one area, where previously international flights were handled $^3/_4$ of a mile away.

The terminal is designed for two-level operation, with enplaning passengers arriving by motor vehicle at the first-floor level (one story above the ground), and deplaning passengers departing from the ground-floor level. The passenger's course of travel from his automobile to the aircraft, and from the aircraft to his automobile, is made as short, as direct, and as nearly in a straight line as possible. See Figs. 1 and 2. The information and ticket counters are directly in front of him as he enters the building. After procuring his ticket and parting with his baggage, he enters the corridor leading to the concourses, and thence goes to his airplane. The waiting room, coffee shop, and other passenger accommodations, all overlooking the apron, are along his line of travel, but are so arranged as not to interfere with the flow of passenger traffic. Baggage of enplaning passengers is taken at the ticket counter and sent to the ground floor level by automatic lifts and chutes.

Enplaning passengers move along the upper level of the concourses, and reach the apron level by gently sloped (10-percent) ramps. There is a small waiting room at the apron level for each gate position along the concourses, so as to keep passengers under shelter if departure is subject to short delays.

Deplaning passengers, after leaving the airplane, go to the first-floor level of the concourse by a 10-percent ramp, travel directly to the Terminal Building and thence down a 10-percent ramp to the ground floor, where they reclaim their baggage and depart to their vehicles at the ground-floor level.

Baggage is moved from the baggage handling space on the ground floor of the Terminal Building to the aircraft, and from the aircraft to the Terminal Building, through the ground-floor level of the concourses, along paths that do not cross the passengers' lines of travel.

The Public Health Service, Immigration, Customs, and related activities are housed in the outer end of Concourse D, so that processing of persons and baggage from foreign countries is completed before they mingle with others.

Air mail, express and freight activities are housed in the Air Mail and Cargo Building located northwest of the Terminal Building. Carts handling this cargo to and from the aircraft travel along the lower level of the concourses, without conflict with walking passengers. Highway vehicles delivering or picking up cargo, load along the south side and east end of the building.

The principal restaurant of the Terminal Building is on the third floor, and from it there is a fine view of the entire landing field and its operations. This restaurant is intended to attract passengers and visitors desirous of good food in interesting surroundings. The airport administrative offices are on the fourth floor. Offices of the U. S. Civil Aeronautics Administration and the Weather Bureau are on the fifth and sixth floors, with some occupancy on the fourth floor. The second floor is taken up mainly by airline offices and spectators' terraces.

There is a Service Building which houses the steam heating plant for the Terminal Building and concourses, as well as the electric substation for the terminal area.

Main features of the new terminal are given in Table I.

Along the west edge of the airport runs the Bayshore Freeway. This is the former Bayshore Highway which had to be relocated in this position as part of the present construction program. The airport contributed $1,250,000 to reimburse the state for the cost of constructing the freeway at the revised location, including an overpass to the airport terminal, plus about $185,000 for drainage culverts and utility-way culverts under the freeway. To prevent a navigational hazard, the electric power poles adjacent to the freeway were relocated and lowered.

The State of California has under construction, or soon will have, the last sections of this freeway which connects the airport to the center of San Francisco. It is expected that the trip from downtown San Francisco, a distance of 14 miles, will soon be accomplished in 20 min. Roads also had to be built from the freeway interchange structure to the terminal area. The main roads are de-

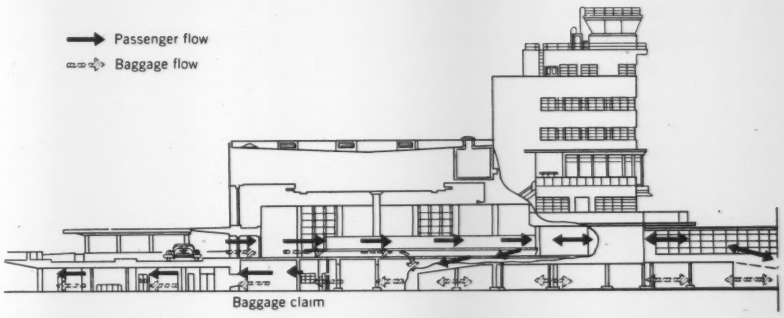


FIG. 1. Passengers' course of travel from automobile to aircraft, and from aircraft to automobile, is made as short and direct as possible. Terminal is designed for two-level operation, with enplaning passengers arriving at first-floor level (one story above ground) and deplaning passengers departing from ground-floor level, after claiming their baggage there.

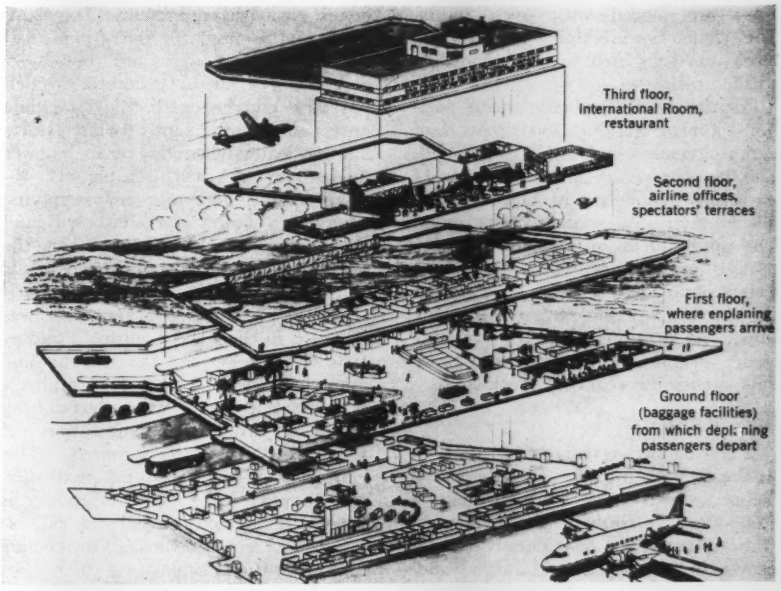

Third floor, International Room, restaurant
Second floor, airline offices, spectators' terraces
First floor, where enplaning passengers arrive
Ground floor (baggage facilities) from which deplaning passengers depart

FIG. 2. As enplaning passenger enters Terminal Building on first-floor level, information and ticket counters are directly in front of him. After procuring ticket and parting with baggage (which is sent by chute to ground floor), he enters corridor leading to concourse, and thence goes to his airplane.

TABLE I. Main features of San Francisco's new terminal

Terminal Building:	
Plan exclusive of vehicular ramps	486 × 303 ft
Plan including vehicular ramps	725 × 303 ft
Height overall	123 ft 4½ in.
Stories, plus tower and mezzanine	7
Floor area	317,097 sq ft
Ticket lobby	380 ft wide, 125 ft 3 in. long, 34 ft high
Air Mail and Cargo Building	42,409 sq ft
Service Building	6,080 sq ft
Concourses	149,534 sq ft
Aircraft loading positions, number	27
Automobile parking positions (exclusive of loading areas)	4,400

signed for one-way traffic with safe and easy access to the terminal. Roads to the Air Mail and Cargo Building are two-way.

Since the new terminal was constructed over marsh and tidal flats, the land had to be reclaimed by placing a 6-ft selected fill over the entire area. The fill, classified as a sandy loam, is of remarkably uniform character. It was placed in loose 12-in. layers, which were then consolidated. In areas to be occupied by aprons and taxiways, the top 3 ft of fill was placed in 6-in. lifts and consolidated to 95 percent. The remainder of the fill was consolidated to 90 percent with a minimum California Bearing Ratio of 20.

To increase the stability of the pavement, the fill under aprons and taxiways was subdrained by a system which consists essentially of pipelines of 6-in. diameter spaced 75 ft on centers. The pipes are placed with open joints. The trench and bedding around the pipes was backfilled with a permeable crushed rock.

For the initial 27 plane parking positions, approximately 1,750,000 sq ft of apron pavement had to be constructed. The base course for this pavement is 14 in. thick, the lowest 4 in. placed on the fill being an open graded crushed rock. The upper 10 in. is crushed rock containing approximately 5 percent by weight of portland cement. The asphaltic concrete wearing surface is $3^1/_2$ in. thick. At locations where the surfacing could be damaged by petroleum products, a chemical seal coat was applied.

Light and power

Electric power is delivered at 12,000 v to the Service Building, and there it is stepped down to 4,160 v through a 1,500-kva transformer. From this substation, power is distributed to load centers in the Air Mail and Cargo Building, Terminal Building, concourses, and Field-Lighting Building. In the Air Mail and Cargo Building, a 225-kva load center reduces the voltage from 4,160 to 120/208 v for distribution within the building.

In the Terminal Building the voltage is reduced from 4,160 v to 120/208 v in each of two 1,000-kva load centers. The lighting load is distributed from each load center via a low-reactance bus duct extending vertically up a riser shaft. At each floor level, a distribution panel is connected to each bus duct and the power is then distributed through cables in conduit to the various lighting panels on that floor. The power load is distributed from the load centers through cables in conduit to the motor control center and various panels throughout the building.

Each of the concourses has two load centers. The lighting load center reduces the voltage to 120/208 for lighting service. These load centers are 150 kva for the two large concourses and $112^1/_2$ kva for the smaller concourse. The power load center reduces the voltage to 480 v, which is then distributed to rectifier positions located immediately outside the building, at the edge of the apron. A 120-v circuit is also brought to the rectifier position from a receptacle circuit within the building. Two 3-in. conduits for low-voltage power and one 1-in. conduit for 120-v service were installed from the rectifier positions to electric service pits at the plane parking positions. The airlines provide the rectifiers for reducing the 480 v to 28 v d-c, and install the cables from the rectifier positions to the service pits. The 28-v d-c power is used for engine starting, to operate air conditioning equipment, and to operate or test electrical equipment. The 120-v a-c power is used for operating small hand tools.

A 125-kva diesel generator, which provides emergency lights in public areas and equipment rooms, starts automatically when the normal power fails. The CAA will soon install a 75-kva standby generator for supplying emergency power for its own and Weather Bureau equipment. In the meantime this load is connected to the 125-kva generator.

A 1,250-kva standby generator was installed in the Field Lighting Building to supply power for the runway and approach lights and the field drainage pumps. Surplus power can be fed back to the Service Building substation and thence distributed as required. This generator also starts automatically, and to reduce the time full power is generated, heated water and oil are pumped as required through the cooling and lubrication systems.

Street lighting in the new terminal area consists of 6,000-lumen, 6.6-amp series lamps on 25-ft steel standards spaced approximately 110 ft apart. This provides an average illumination of about 0.4 ft-candles. Lighting standards were provided with transformer bases so that the street lighting system can be converted to mercury luminaires if higher levels of illumination are desired in future.

Gasoline hydrant system

A gasoline hydrant system has been installed by the Standard Oil Company of California to distribute that company's aviation fuel. The system consists of six principal elements (Fig. 3):

1. Bulk plant provides tank-farm storage for approximately 1,400,000 gal close to the seaplane harbor. Fuel is received by barge from the refinery.

2. Two transfer pipelines keep satellite storage filled from the main tank-farm storage. Two 150-gpm transfer pumps are located in the bulk plant area, but controlled from the satellite storage area. Safety devices have been incorporated to transfer products accurately and safely between the storage areas.

3. Satellite storage consists of eight 25,000-gal tanks, located at the north end of the new terminal concourse, to supply large quantities of fuel to the airport at high fueling rates during peak fueling periods. The pumps, filter, and controls are also located within this area.

4. Five main-supply pipelines carry four grades of fuel to the individual concourses.

5. Concourse piping feeds hydrants, which supply two grades of fuel at each position. One position at the end of Concourse B has been provided for jet fuel.

6. Hydrant dispensers will be provided. Self-propelled hydrant carts will be supplied by one airline; the remainder will be trailer-type, provided by the gasoline company. The carts are equipped with hoses, nozzles, meters, air eliminators, shock absorbers, micronic filters, and flow regulators. The hydrant valves are quick connecting, dry-break, two-part devices, one-half being connected to underground pipelines located just below the surface of the paving, and the other half attached to the cart connecting hose. Neither half can be opened when disconnected. This device allows the hydrant carts to be connected and disconnected to the underground pipelines without loss of gasoline and attendant fire hazards.

Twenty plane parking positions are provided with two hydrants each of 200-gpm capacity, giving a maximum capacity of 400 gpm per plane. As demand increases, expansion of the system to include the present 27 parking positions will be relatively simple.

To take care of telephone requirements in the terminal area, 80 public telephones have been installed. Since deplaning passengers usually make more calls than enplaning ones, two groups of public telephones are located on the ground level adjacent to the baggage claiming area. In addition there is another group located near the airline ticket and information counters. Other public telephones are scattered throughout the terminal.

Public telephones are only one part of the telephone service at the new terminal. There are three dial PBX

units with facilities for 500 telephones for airport administrative purposes and the use of airlines.

Special emergency alerting systems, teletypewriters, direct connections to the Coast Guard, Weather Bureau, and Oakland Airport are among the telephone services at the airport. Voice circuits alone in and out of the Terminal Building require a 900-pair cable about 2.8 in. in diameter.

Project costs

During the present project, which started in 1945, approximately $21,140,000 has been spent for land purchases, fill, runways and taxiways, landing aids, and miscellaneous landing field improvements; and about $14,160,000 has been spent for developing the new terminal area including buildings, aprons and road paving, and utility extensions. The $14,161,000 spent in developing the new terminal can be broken down as follows:

Terminal Building	$ 6,780,000
Concourses	1,380,000
Air Mail and Cargo Building	440,000
Service Building and central heating plant	200,000
Utilities	480,000
Apron, roads, parking areas, walks, etc	2,220,000
Standby power plants	160,000
Reclaiming land for terminal site and miscellaneous	2,500,000
Total	$14,160,000

Of the revenues received by the airport management, approximately 20 percent are from landing fees. Most of the remainder is generated in the terminal area, which was planned to develop maximum revenue from concessions without permitting any obstruction to major traffic circulation. The revenue generated at the new terminal is gratifying, and it is expected that the airport will be out of the red in two years.

Design of the new terminal buildings was essentially completed in 1951, and the first call for bids was made in June of that year. The first day of traffic through the new terminal was September 1, 1954. During this long interval, air traffic at the airport increased from 1,508,760 in 1950 to 2,670,000 in 1954. This large increase caused the various tenants and airlines to revise their requirements during construction, with consequent modifications of the plans.

If more money had been available we would have liked a larger Air Mail and Cargo Building. The layout, whereby this structure is separate from the Terminal Building, is working out satisfactorily. All available space is being utilized however, and with increased traffic, this structure will have to be enlarged.

The shortage of funds was also responsible for the fact that Pier E was not constructed initially. As soon as additional funds become available, Pier E will be built and additional vehicle parking space will be paved.

If the Terminal Building were being planned now, without present knowledge, the waiting room would be larger. If the present trend continues, this area will soon become crowded and additional space will have to be obtained. The present waiting room has approximately 9,700 sq ft of floor space.

The arrangement whereby baggage is lowered from the first to the ground floors by means of automatic lifts and chutes is believed to be unique. After a short break-in period this operation has become very efficient. Inquisitive children caused a problem at first, and it was found desirable to install barriers to keep them from falling down the chutes.

It is believed that the configuration of the piers would have been more efficient if they had been planned for 11 instead of 9 plane parking positions. This arrangement would have permitted a more compact design of the terminal area.

The new terminal has now been in operation for approximately seven months, and with the exceptions noted is functioning as planned. We believe it is the finest in the world.

(This article is based on the paper presented by Mr. Bardoff at ASCE's San Diego Convention, before a session of the Air Transport Division presided over by Dewey S. Wright, Division Secretary.)

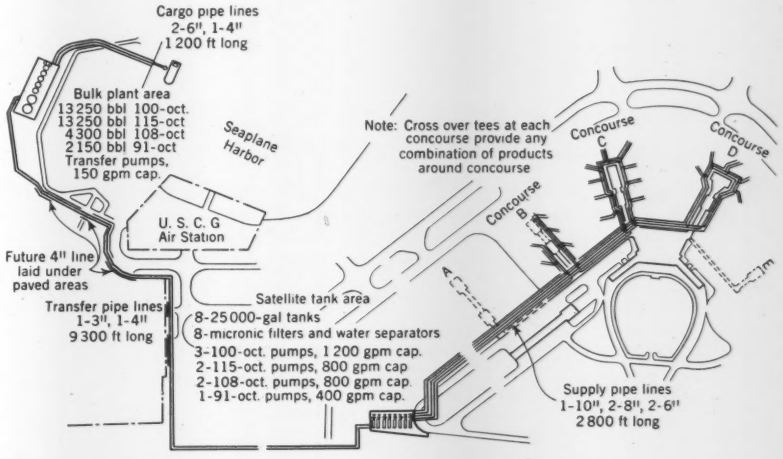
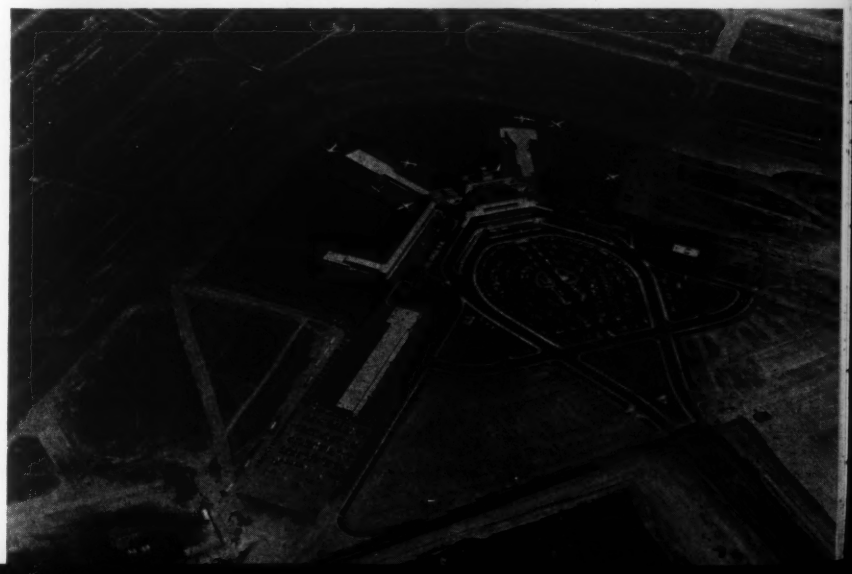

Cargo pipe lines
2-6", 1-4"
1 200 ft long
Bulk plant area
13 250 bbl 100-oct.
13 250 bbl 115-oct
4 300 bbl 108-oct
2 150 bbl 91-oct
Transfer pumps,
150 gpm cap.
Seaplane Harbor
U. S. C. G. Air Station
Future 4" line laid under paved areas
Transfer pipe lines
1-3", 1-4"
9 300 ft long
Satellite tank area
8-25 000-gal tanks
8-micronic filters and water separators
3-100-oct. pumps, 1 200 gpm cap.
2-115-oct. pumps, 800 gpm cap.
2-108-oct. pumps, 800 gpm cap.
1-91-oct. pumps, 400 gpm cap.
Note: Cross over tees at each concourse provide any combination of products around concourse
Concourse B
Concourse C
Concourse D
Supply pipe lines
1-10", 2-8", 2-6"
2 800 ft long

FIG. 3. Aviation fuel service system includes storage facilities, distribution lines, and gasoline hydrants at plane positions.

Air view of Terminal Building shows general layout of area, with parking space in rear and plane loading aprons in front.



ENGINEERS' NOTEBOOK

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Intermediate elevations on vertical curves found by addition of increments

Computation of interior elevations at stations along vertical curves for roads and airfields is often an onerous task. The method here presented, using addition of increments, greatly eases the burden of number work, especially where machine computation is feasible.

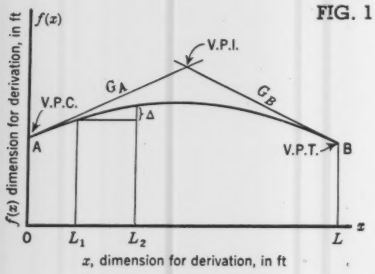

FIG. 1

I do not know of any similar method currently in use.

In the derivation (Fig. 1), the following notation is used:

G_A = slope of tangent in to vertical curve, in percent
G_B = slope of tangent out of vertical curve in percent
L = length of curve in stations
A = elevation of V.P.C., in ft
B = elevation of V.P.T., in ft
L_1, L_2 = distances from origin to any two selected stations, in stations

Boundary conditions: Let $f(x) = K_1 + K_2 x + K_3 x^2$ to describe the assumed parabolic curve.

When $x = 0$, $f(x) = A$. Therefore $K_1 + O + O = A$,

and $K_1 = A$ . . . . . (1)

When $x = 0$, $f'(x) = G_A \times \frac{1}{100}$.

Therefore $K_2 + 2K_3\,(0) = \frac{1}{100}\,G_A$,

and $K_2 = \frac{1}{100}\,G_A$ . . . . . (2)

When $x = 100L$, $f'(x) = G_B \times \frac{1}{100}$.

Therefore $\frac{G_A}{100} + 2K_3(100L) = \frac{1}{100}\,G_B$,

and $K_3 = \frac{G_B - G_A}{2\,(100)^2 L}$ . . . . . (3)

Therefore

$$f(x) = A + \frac{G_A}{100}\,x + \frac{G_B - G_A}{2\,(100)^2 L}\,x^2$$

Let $x = 100L_1$; then $f(x) =$

$$A + \frac{G_A\,(100L_1)}{100} + \frac{G_B - G_A\,(100L_1)^2}{2\,(100)^2\,L}$$

Let $x = 100\,L_2$; then $f(x) =$

$$A + \frac{G_A\,(100\,L_2)}{100} + \frac{G_B - G_A\,(100L_2)^2}{2\,(100)^2\,L}$$

$f\,(100L_2) - f(100L_1) = \Delta$

$$\Delta = G_A(L_2 - L_1) + \frac{G_B - G_A}{2\,L}\,(L_2^2 - L_1^2)$$

$$\Delta = G_A(L_2 - L_1) + \frac{G_B - G_A}{2L}\,(L_2 + L_1)\,(L_2 - L_1)$$

$$\Delta = [L_2 - L_1] \times \left[G_A + \frac{(G_B - G_A)}{2\,L}\,(L_2 + L_1)\right] \quad . . \quad (4)$$

TABLE I. Solutions to illustrative problem

$$\Delta = [L_2 - L_1]\left[2 + \frac{(-3 - 2)}{2 \times 18}\,(L_2 + L_1)\right] = [L_2 - L_1]\,[2 - 0.139(L_2 + L_1)]$$

STATION	L_1	L_2	$L_2 - L_1$	$L_2 + L_1$	Δ, FT	EL., FT
25 + 76 (V.P.C.)	0.00	0.00	....	....	.....	136.0
26 + 00	0.00	0.24	0.24	0.24	+0.472	136.47
26 + 50	0.24	0.74	0.5	0.98	+0.932	137.41
27 + 00	0.74	1.24	0.5	1.98	+0.862	138.27
27 + 50	1.24	1.74	0.5	2.98	+0.793	139.06
28 + 00	1.74	2.24	0.5	3.98	+0.724	139.78
28 + 50	2.24	2.74	0.5	4.98	+0.654	140.43
29 + 00	2.74	3.24	0.5	5.98	+0.585	141.01
29 + 50	3.24	3.74	0.5	6.98	+0.515	141.53
30 + 00	3.74	4.24	0.5	7.98	+0.446	141.97
30 + 50	4.24	4.74	0.5	8.98	+0.376	142.41
31 + 00	4.74	5.24	0.5	9.98	+0.307	142.72
31 + 50	5.24	5.74	0.5	10.98	+0.237	142.96
32 + 00	5.74	6.24	0.5	11.98	+0.168	143.13
32 + 50	6.24	6.74	0.5	12.98	+0.099	143.23
33 + 00	6.74	7.24	0.5	13.98	+0.029	143.26
33 + 50	7.24	7.74	0.5	14.98	−0.040	143.22
34 + 00	7.74	8.24	0.5	15.98	−0.110	143.11
34 + 50	8.24	8.74	0.5	16.98	−0.179	142.93
34 + 76 (V.P.I.)	8.74	9.00	0.26	17.74	−0.121	142.81

Example of Use

Given: G_A = +2 percent; G_B = −3 percent; L = 18 Sta.

Assume V.P.C. at 25 + 76, and it is desired to record intermediate elevations at 50-ft horizontal intervals beginning at 26 + 00. The solutions are listed in Table I, beginning with the elevation of V.P.C., which is 136.0

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Circular arcs and circular segments calculated

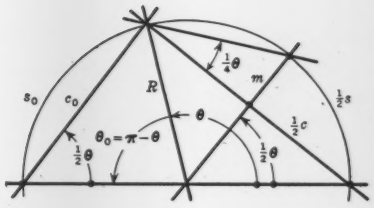

FIG. 1. In circle of radius R, s and c are lengths of an arc and its chord that subtend central angle θ.

Calculation of the lengths of circular arcs and the areas of circular segments admits of an easy and accurate solution, in which a rapidly converging infinite series can be applied. In the work that follows, only a sufficient number of terms of the series are retained to ensure an accuracy of a unit or less in the sixth decimal place, that is, an accuracy better than one in one million. That degree of accuracy suffices for practically all engineering computation work.

The results are expressed in terms of the original data, that is, the lengths of the radius, the chord, and the mid-ordinate. The need for tables of trigonometric functions is entirely eliminated. The series to be employed is an adaptation of one derived in works on trigonometry, namely:

$$\frac{\frac{1}{2}\theta}{\sin\frac{1}{2}\theta} = 1 + \left(\frac{2}{3}\sin^2\frac{1}{4}\theta\right) + \left(\frac{2}{3}\frac{4}{5}\sin^4\frac{1}{4}\theta\right) + \left(\frac{2}{3}\frac{4}{5}\frac{6}{7}\sin^6\times\frac{1}{4}\theta\right) + \ldots \quad . \quad . \quad (1)$$

In the accompanying Fig. 1, s and c are lengths of an arc and its chord that subtend the central angle θ in a circle of radius R. The length of the corresponding mid-ordinate is m.

From Fig. 1,

$$\sin\tfrac{1}{2}\theta = \frac{c}{2R} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\cos\tfrac{1}{2}\theta = \sqrt{1-\left(\frac{c}{2R}\right)^2} \quad . \quad . \quad (3)$$

$$\left(\frac{c}{2}\right)^2 = m(2R-m) \quad . \quad . \quad . \quad (4)$$

Also from Fig. 1,

$$\frac{s}{c} = \frac{\frac{1}{2}s}{\frac{1}{2}c} = \frac{R\frac{1}{2}\theta}{R\sin\frac{1}{2}\theta} = \frac{\frac{1}{2}\theta}{\sin\frac{1}{2}\theta} \quad . \quad . \quad . \quad . \quad (5)$$

in which the expression on the right is equal to the series in Eq. 1. For brevity write,

$$\sin^2\tfrac{1}{4}\theta = \tfrac{1}{2}(1-\cos\tfrac{1}{4}\theta) = \tfrac{1}{2}\left(1-\sqrt{1-\left(\frac{c}{2R}\right)^2}\right) \equiv S^2 \quad . \quad . \quad . \quad (6)$$

Whence $\cos\frac{1}{2}\theta = (1-2S^2)$ . . . . (7)

also, eliminating $c/2$ from Eqs. 4 and 6,

$$S^2 = \frac{m}{2R}, \text{ or } m = 2RS^2 \quad . \quad . \quad (8)$$

Also for brevity write,

$$\left.\begin{aligned} K_0 &= 1 \\ K_2 &= \tfrac{2}{3}S^2K_0 \\ K_4 &= \tfrac{4}{5}S^2K_2 \\ K_6 &= \tfrac{6}{7}S^2K_4 \\ K_8 &= \tfrac{8}{9}S^2K_6 \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (9)$$

Hence, by Eqs. 5 and 6, the series of Eq. 1 can be written in the form,

$$s = c(1 + K_2 + K_4 + K_6 + K_8 + \ldots) \quad . \quad . \quad . \quad . \quad (10)$$

in which the successive terms are computed by the recurrence rule of Eq. 9.

For values of the central angle $\leqq 90$ it is not necessary to calculate any term of the series of Eq. 10 beyond K_6. For that term and all succeeding terms, an easily computed remainder term can be used. Write

$$R_6 = K_6 + K_8 + K_{10} + \ldots$$

Then, within the required degree of accuracy,

$$R_6 = \frac{K_6}{1-\frac{8}{9}S^2}$$

and hence the closed expression,

$$s = c(1 + K_2 + K_4 + R_6) \quad . \quad . \quad (11)$$

is obtained.

For values of the central angle,

$$90 \text{ deg} < \theta < 120,$$

the remainder term,

$$R_8 = \frac{K_8}{1+\frac{10}{11}S^2} \quad . \quad . \quad . \quad . \quad (12)$$

also can be used, if desired, giving

$$s = c(1 + K_2 + K_4 + K_6 + R_8) \quad . \quad (13)$$

For larger values of the central angle, say for $\theta > 120$, the series of Eq. 10 converges too slowly for convenient use; and there is no need, in any case, to consider a series in which $\theta > 90$. It is better, in such cases, to make use of the quantities, θ_0, s_0, c_0, S_0, K_0, appertaining to the supplemental sector, for which $\theta_0 = \pi - \theta$.

Then, from Fig. 1, and using Eq. 7,

$$c_0 = 2R\cos\tfrac{1}{2}\theta = 2R(1-2S^2) \quad . \quad (14)$$

$$s_0 = \sin^2\tfrac{1}{4}\theta_0 = \tfrac{1}{2}\left(1-\frac{c}{2R}\right) \quad . \quad . \quad (15)$$

whence by Eq. 11,

$$s_0 = c_0(1 + K_{02} + K_{04} + R_{06}) \quad . \quad (16)$$

and

$$s = R\pi - s_0 \quad . \quad . \quad (17)$$

The segmental area, A, is also readily expressed in terms of K_2, K_4, K_6, etc.

From Fig. 1,

$$A = \tfrac{1}{2}(R^2\theta - 2R\sin\tfrac{1}{2}\theta R\cos\tfrac{1}{2}\theta) = \tfrac{1}{2}R(s - c\cos\tfrac{1}{2}\theta)$$

or from Eqs. 7 and 8,

$$A = \tfrac{1}{2}R(s - c + 2cS^2) = \tfrac{1}{2}mc + \frac{m}{4S^2}(s-c) \quad . \quad . \quad . \quad (18)$$

This expression for A is valid for all values of $\theta \leqq 180$.

For values of the central angle such that $\theta \leqq 90$, write, from Eq. 11,

$(s - c) = c(\frac{2}{3}S^2 + K_4 + R_6)$, giving

$$A = \tfrac{1}{2}mc + \frac{mc}{4S^2}(\tfrac{2}{3}S^2 + K_4 + R_8)$$

or finally,

$$A = mc\left(\tfrac{2}{3} + \frac{K_4 + R_6}{4S^2}\right) \quad . \quad . \quad . \quad (19)$$

Where should a steel column be spliced?

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In the summer of 1954, while doing some work for R. L. Eason & Associates of St. Louis, Mo., the writer was faced with the desirability of finding out if and where it might be preferable to splice a steel column carrying primarily axial loads. There being available no test data, nor the time and facilities required to set up an extensive physical investigation, it became necessary to reduce the problem to some ideal consideration, and then by inference attempt to draw some reasonable conclusions.

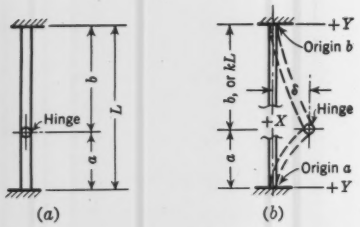

FIG. 1. Ideal column, (a), is fixed at both ends and assumed to have constant cross-section over length L. If lateral displacement is applied at hinge, as in (b), Euler load is that load which is just sufficient to hold deflected structure in place.

The ideal problem is shown in Fig. 1 (*a*), where for the sake of simplification, the ideal column, fixed at both ends and with an intermediate hinge, is assumed to have a constant cross section over the length, L. As shown in Fig. 1 (*b*), if a lateral displacement of δ is applied at the hinge, the Euler load is that load just sufficient to hold the deflected structure in place. Choice of the sign convention shown, with positive moment producing tension in the fibers nearer the positive direction of the Y-axis, and considering only the primary energy effects of flexure, leads to the general expression,

$$M/EI = -d^2y/dx^2 \quad . \quad . \quad . \quad (1)$$

Substitution of the values of M, shown in Fig. 2, gives,

$$d^2y/dx^2 = [P(\delta - y) - Q(b - x)]/EI \quad . \quad . \quad . \quad (2, \text{ top})$$

$$d^2y/dx^2 = [P(\delta - y) + Q(a - x)]/EI \quad . \quad . \quad . \quad (2, \text{ bottom})$$

If p is taken such that $p^2 = P/EI$, then the solution of these two differential equations, plus consideration of the boundary conditions that, at $x = 0$ for each segment, both $y = 0$ and $dy/dx = 0$, leads finally to the expressions,

$$y = (\cos px)\,(Qb - P\delta)/P - (\sin px)\,(Q/pP) + (P\delta - Qb + Qx)/P \quad . \quad (3, \text{ top})$$

$$y = (\cos px)\,(-Qa - P\delta)/P + (\sin px)\,(Q/pP) + (P\delta + Qa - Qx)/P \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3, \text{ bottom})$$

For the top portion, at $x = b$, $y = \delta$; and for the bottom, at $x = a$, $y = \delta$. These facts lead to the single equation,

$$(\sin pL)/pL = (\cos kpL) \times [\cos (1 - k)\,pL] \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

in which $kL = b$; $(1 - k)L = a$.

The transcendental Eq. 4 can be solved by some numerical method for values of pL depending upon values of k. With the values of

$$\frac{(pL)^2}{\pi^2}$$

designated by the constant C, the critical Euler load may be stated as,

$$P_{CR} = C\pi^2EI/L^2 \quad . \quad . \quad . \quad . \quad (5)$$

Values of the constant C, for different values of k, are given in Table I, and a graph that conveniently illustrates the results is shown in Fig. 3. The Euler load, it may be noted, falls always

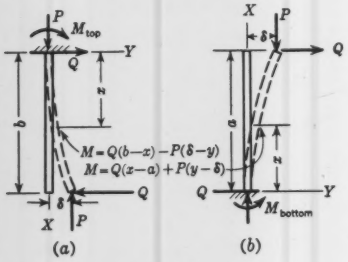

FIG. 2. Free body sketches give values of moments, M.

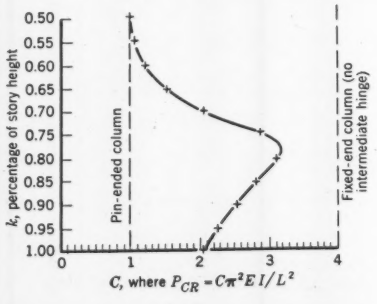

FIG. 3. For ideal column of Fig. 1 (*a*), constant C is plotted for different values of k, from Table I.

TABLE I. Values of C in $P_{CR} = C\pi^2EI/L^2$

k	pL	C
1.00 . . .	4.492 (257°27′)	2.04
0.95 . . .	4.731 (271°0′)	2.27
0.90 . . .	4.996 (285°57′)	2.53
0.85 . . .	5.271 (302°6′)	2.82
0.80 . . .	5.542 (317°45′)	3.11
0.75 . . .	5.344 (306°6′)	2.89
0.70 . . .	4.509 (258°12′)	2.06
0.65 . . .	3.875 (222°2′)	1.52
0.60 . . .	3.462 (198°10′)	1.21
0.55 . . .	3.223 (184°28′)	1.05
0.50 . . .	3.142 (180°)	1.00

between the limits of a pin-ended column and one that is fixed at each end, neither limit containing any intermediate hinge.

Location of the hinge in the outer quarter actually strengthens the column relative to the initial position of $k = 1$. But location in the middle half, approximately, will materially weaken the column, particularly as the vicinity of $k = 0.5$ is neared.

In a qualitative application of the above results, several variables may create a considerable departure from the ideal analysis. Usually the lower part of the splice in ordinary building construction will be made of a heavier section than the upper, thereby strengthening the column as a whole, considering the preceding analysis as based on a constant cross section.

An unpredictable variable is the condition of the adjoining surfaces of the spliced ends. If these are accurately milled and carefully aligned during erection, then up to a certain point, as the column deflects outward, it will act practically as one continuous member, as long as no uplift results on the "tension" side (that is, if Mc/I remains less than P/A). Once uplift does occur on the contacting ends, the column reverts to the category of a hinged connection, which is here being investigated (assuming the splice can develop only negligible moment).

In drawing the following conclusions from a perusal of the graph and the preceding comments, the writer is guided by an attempt at simplification and reasonable conservatism:

1. In columns that are truly long, such as occasional bracing members which might also be carrying a design load, or even the rare main member that falls into this category, splices should be avoided in the middle half. If this is impossible, then it seems desirable to design a splice that will develop some reasonable amount of moment which could offset possible joint eccentricity. An arbitrary deflection could be assigned in arriving at a safe yet fairly economical design.

2. In the ordinary column, in view of the preceding discussion, such a recommendation is not an absolute necessity. But considering all of the many variables, both predictable and unpredictable, it is highly desirable for *all* splices to be located in the outer quarters of the story height. For purposes of erection convenience, this practice has generally been followed for many years. The evidence is that column behavior has never seemed to be anything but satisfactory.

The writer is indebted to T. R. Higgins, M. ASCE, Director of Engineering, American Institute of Steel Construction, for helpful comments.

THE READERS WRITE

Are young civil engineering graduates needed in construction?

TO THE EDITOR: As a college teacher, I once more am seeing a graduating class of civil engineers making the difficult but important decision as to what to do after college. Each must choose an organization with which to ally himself. For the student, this is a time-consuming but a stimulating and productive experience during which he learns something about the world away from the ivied towers.

Coming into the senior year, students usually express a heavy first interest in construction work and a second interest in engineering design, two of the most important and most typical civil engineering activities. However, only a relatively small precentage of graduates actually go into these fields (contracting, 13 percent; consulting engineering, 15 percent; highway departments, 14 percent; civil service, 14 percent). Where do they go, and why?

The method of recruiting graduating engineers at Princeton University is undoubtedly fairly typical. Approximately 200 concerns visit the campus to contact, through the Princeton University Placement Bureau, the 125 prospective engineering employees. The average student has about 10 interviews from which 3 or 4 definite job offers result. The typical civil engineering activities of contracting and consulting engineering, however, are not part of that recruiting picture, with the exception of two or three well known construction firms.

If a student is interested in entering the construction field, and if none of these particular firms happens to be visiting the campus this year, either he must hunt up a job himself by using the leads of the Placement Bureau and the firm names appearing in magazine articles, or he must ask his instructors to help him out—and frankly they are rarely well equipped to do so. If he is interested in entering the consulting engineering field, he ordinarily has to wait until one of his instructors contacts him with an employment opportunity of which the instructor has been informed by a friend in a consulting firm. Or a consulting firm may send a blanket request to the Civil Engineering Department asking the chairman to do the recruiting. In any case, the graduating civil engineer does not find the usual doors open through which to pass into contracting or consulting engineering.

The fact is that the graduating engineer is in a sellers' market. The concern that wants to hire a young engineer must go out and convince him that it has something to offer, and do this actively in competition with other concerns which also need the new graduate. Not only must an attractive starting salary be offered, but desirable working conditions and opportunities must be played up. Also, the young graduate now realizes that four years in college do not make a finished engineer, and he wants to know what additional training he will receive to make him more valuable and better paid. The present college graduate is more mature in many ways, and he tries to think some of these things through. He looks before he leaps, and he does less shifting from job to job than his predecessors did.

The larger industrial concerns that need engineers recognize the situation and have altered their techniques to meet existing conditions. Times have changed! It is not like the "good old days," and if we are to believe the publicity about the importance of engineers in our economy, there probably will not be a return to the buyers' market for a long time. Civil engineering firms must recognize this situation and compete with other firms looking for engineering talent. They must not depend on a friendly faculty member with a nominal interest in their firm to compete at no expense to them with a skilled personnel buyer of engineering talent.

If we are to assume that contractors and consulting engineers know what they are doing, then it appears that young graduating engineers are not badly needed, either as to quantity or quality, by such organizations. However, the opposite tack has been taken by many authorities in the past year or so. Major Lenox R. Lohr, M. ASCE, at the 62nd Annual Meeting of the American Society for Engineering Education, stated that more and better engineers are needed, and that careers in engineering must be sold to young people in increasing numbers.

More recently, Donald R. Quarles, Assistant Secretary of Defense, at an EJC banquet, said that engineers are scarce. Getting closer to civil engineering specifically, Dwight W. Winkleman, M. ASCE, speaking before the ASCE Annual Convention in New York, as reported in the February 1955 issue of CIVIL ENGINEERING, pointed out the dependence on, and need for, engineers in construction management. And this is the industry which is the largest in the United States in dollar volume, according to Carl B. Jansen, M. ASCE, in the December 1954 issue.

Do we need more engineers or do we not? Do contracting and consulting engineering firms have an adequate supply of young civil engineers without developing a recruiting system? If the supply is adequate, then I believe we are morally obligated to stop talking so much about the shortage of civil engineers, and quit influencing young men to take up civil engineering. But if there is a shortage of young engineers, there is a strong moral obligation for engineering and construction firms to get into the college recruiting swirl and attract the better civil engineering graduates into construction and civil engineering work.

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Limitations of logic in engineering education

TO THE EDITOR: My attention has been called to the letter by Prof. S. J. Mazur, in the April issue (p. 63) commenting on my article, "Is Civil Engineering Being Taught Backward?" (January 1955 issue, p. 57).

Professor Mazur properly emphasizes the educational importance of the basic sciences as compared with the practical arts. The point, however, that he seems to be overlooking is that from a professional viewpoint the creative arts are fully as important as are the basic sciences.

Since my brief article in the January issue appears to have been misconstrued by Professor Mazur, I should like to call his attention, and the attention of others interested in engineering education, to a more recent paper, "The Limitations of Logic in Engineering Education," published in the March issue of the *Technology Review*, the Alumni publication of Massachusetts Institute of Technology. I would be glad to send a reprint of this paper to any member of the Society.

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Free-overflow has rapidly varying characteristics

TO THE EDITOR: The article, "Hydraulic Drop as a Function of Velocity Distribution," by Charles Grant Edson (December 1954, p. 64) contains what the writer believes to be a number of misconceptions. Before presenting my specific comments, it would be helpful to review some characteristics of the free overfall or brink in a rectangular channel.

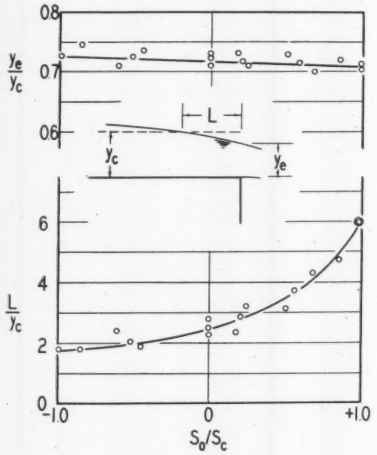

Fig. 1. Characteristics of the free overfall.

The flow in the vicinity of a free overfall is definitely non-uniform and is called rapidly varying in open-channel-flow terminology. The variations in piezometric head as well as velocity in a normal cross section of these zones preclude the use of a one-dimensional analysis. The one-dimensional analysis can only be utilized for rapidly varied flow analysis where the end sections of the rapidly varied flow zone are in uniform or gradually varied flow zones, for example, as in the hydraulic jump. The free overfall is not one of these cases. Consequently the characteristics of the free overfall must either be experimentally measured or determined from a flow net in which the prerequisite dynamic relations are satisfied at every point within this rapidly varying flow zone.

Rouse (*Civil Engineering*, April 1936, p. 257) recognized the free overfall as one limit of the rectangular suppressed weir, that is, a weir of zero height. Since the rectangular suppressed weir (including the free overfall) is a control section, the flow characteristics are uniquely determined by geometry, viscous forces, and capillary forces. These latter two forces have been found to be insignificant on the useful range of the weir. On the other hand, the velocity distribution in the approach channel can be expected to be increasingly important as the weir height is reduced. Also the bottom slope, S_0, can be expected to influence the flow characteristics when this slope is materially different from zero. Thus

$$y_e/y_c = \phi(\epsilon/y,\ q/\nu,\ S_0) \quad . \quad . \quad . \quad (1)$$

in which the ratio of brink depth to critical depth, y_e/y_c, is a function of relative roughness ϵ/y, the Reynolds number q/δ, and the bottom slope, S_0. A further simplification can be made by using the critical slope S_c, which incorporates the essential factors that led to the inclusion of ϵ/y, and q/ν.
Thus

$$y_e/y_c = \phi(S_c,\ S_0) \quad . \quad . \quad . \quad . \quad (2)$$

Holt in an unpublished Master's thesis of Georgia Institute of Technology, "Analysis of Flow Through Highway Culverts," 1953, made some depth determinations at a free overfall. The data were not sufficiently extensive to establish the functional relationship of Eq. 2. Holt's data are graphically shown in Fig. 1. The minor variation in the value of y_e/y_c from adverse slopes, $S_0/S_c < 0$, to the critical slope, $S_0/S_c = 1$, is apparent.

Some of the specific points on which the writer does not agree with Professor Edson are:

1. In his Fig. 1, the free surface is labeled as the hydraulic grade line. However, in a rapidly-varied flow zone the free surface is only the hydraulic grade line for those particles on the streamline which is the free surface. Consequently, the concept of the hydraulic grade line which is invaluable in gradually varied flow analysis is of limited utility in this case.

2. The expression involving the kinetic-energy correction coefficient is in error. The correct expression is as follows:

$$\alpha \frac{V^2}{2g} = \frac{1}{q}\int_0^{y_e} \frac{v^2}{2g}\,dq = \frac{1}{q}\int_0^{y_e} \frac{v^2}{2g}\,v_x dy. \quad (3)$$

The evaluation of α was to be obtained over the cross section which is vertically above the brink, that is, $0 < y < y_e$. Owing to the appreciable curvature of the streamlines, the velocity vector varies in direction over this section. Therefore,

$$dq = v_x dy \neq v dy$$

This point is not often in question since the concept of α is useful primarily in the one-dimensional analysis of gradually varied or uniform flow for which the velocity vector can be considered perpendicular to the cross section.

3. The writer disagrees with Professor Edson, firstly, as to the wisdom of using one-dimensional analysis and, secondly, as to the manner in which he uses it. The one-dimensional energy equation is a *scalar* equation. To be applied at the brink of a free overfall, this equation would be as follows:

$$H = \alpha_1 \frac{V^2}{2g} + \alpha_2 y_e = \frac{1}{q}\int_0^{y_e} \frac{v^2}{2g}\,v_x dy + \frac{1}{q}\int_0^{y_e} \left(\frac{p}{\gamma} + y\right) v_x dy \quad . \quad . \quad (4)$$

The term α_1, is the kinetic energy correction coefficient necessary in order that the product of $\alpha_1 V^2/2g$ will be equal to the average kinetic energy in the cross section. The term α_2 is necessary in order that the product $\alpha_x y_e$ will be equal to the average piezometric head at the same section. To determine α_1, the functional relationship between v, v_x, and y must be known or its value grossly estimated. Similarly, to determine α_2, the functional relationship between p, v_x and y must be known. In this connection it is unwarranted to assume $p = 0$ merely because the boundary conditions are such that $p = 0$ at both $y = 0$ and $y = y_e$. In short, since p, v, and v_x must be known functions of y at the brink in order to apply the one-dimensional analysis, the futility of this approach other than by gross assumption seems evident.

4. The velocity distributions assumed at the brink are unrealistic. Since the flow zone is one involving appreciable accelerations, the velocity distribution at the brink will be primarily the result of inertia forces rather than shear forces. Even though the velocity distribution might be parabolic in the channel approaching the brink, the predominant action of accelerative forces at the brink can be expected to alter this distribution so as to increase the velocity magnitude in the lower stream filaments.

M. R. CARSTENS, A.M. ASCE
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Atlanta, Ga.

admittedly the weakest link in the chain. Accepting the approximation for what it's worth, we get

$$D_f = \frac{\int_0^D v^2 v_x\, dy}{4g\int_0^D v_x\, dy} = \frac{\int_0^D v^3 \cos\theta\, dy}{4g\int_0^D v\cos\theta\, dy}$$

which differs from Eq. 2 in the original article only by the inclusion of $\cos\theta$.

This brings us to one of the issues raised by Professor Carstens:

$$\alpha\frac{V^2}{2g} = \frac{\int_0^D v^3\cos\theta\, dy}{2g\int_0^D v\cos\theta\, dy} \approx \frac{\int_0^D v^3\, dy}{2g\int_0^D v\, dy}$$

Here the approximate equation is probably good enough for engineering practice. Should greater accuracy be required, however, there is nothing to prevent use of the exact equation. Whichever definition be adopted for α, the end result will be the same:

$$D_f/D_c = \sqrt[3]{\alpha_f/4\alpha_c}.$$

What I can't understand is how anyone can regard the foregoing analysis as one-dimensional. The variations in both p and v have been integrated over the entire depth. What else is there? Perhaps we have all become such slaves to the flow-net technique that we can't possibly imagine its being circumvented.

On the matter of velocity distribution, I concede that I may have been a bit casual, but this is secondary to the main issue. Velocity distribution could easily provide the answer to every question in rapidly varied flow, but there isn't much point in delving into it until some part of the profession is able to recognize its usefulness in a phenomenon as elementary as the hydraulic drop.

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Additional comments on the hydraulic drop

TO THE EDITOR: Professor Carstens' comments together with those of Professor Dooge (February 1955 issue, p. 66) would seem to indicate that I may have been a bit summary in my article on the hydraulic drop in the December 1954 issue (p. 64). Surely the results are not so untenable as these gentlemen would imply. I should like, therefore, to add a few comments of my own so that the engineering usefulness of the article may not be lost in their well-intentioned striving for mathematical exactitude.

At the expense of generality, let us concentrate on the specific energy head at the channel bottom. This will preclude any question concerning the local pressure at the fall, for everyone seems to agree that p_0 is zero at that section. But because p_0 is intrinsically a static observation, its equivalent value must be computed statically; that is, the dynamic acceleration, a, must be reversed (d'Alembert's principle). For the velocity head, however, the data are intrinsically dynamic, so that a should be added directly to g with no change in sign. The accompanying Fig. 1 shows exactly what's going on. Note that an angle θ has been introduced to distinguish the local velocity, v, from its v_x component.

Now in any computation for H, the effect of a may be applied either to the potential component or to the kinetic component, but never to both. When applied exclusively to the potential component,

$$H = \frac{\int_0^D \rho(g \rightarrow a)\cos\theta dy}{\rho g} + \frac{\int_0^D v^2 v_x\, dy}{2\int_0^D g\, v_x\, dy}$$

$\cos\theta$ appearing in the potential energy term because the force per unit volume, $\rho(g \rightarrow a)$, is not parallel to the infinitesimal displacement, dy. Contrariwise, when a is applied exclusively to the kinetic component

$$H = \frac{\int_0^D \rho g\, dy}{\rho g} + \frac{\int_0^D v^2 v_x\, dy}{2\int_0^D (g \rightarrow a) v_x\, dy}$$

with $\cos\theta = 1$ in the potential energy term. At the fall,

$$\frac{\int_0^D \rho g\, dy}{\rho g} = D_f$$

$$\int_0^D \rho(g \rightarrow a)\cos\theta\, dy = p_0 = 0$$

Whence by addition,

$$\int_0^D g \rightarrow a)v_x\, dy = \int_0^D (g \rightarrow a)v\cos\theta\, dy$$

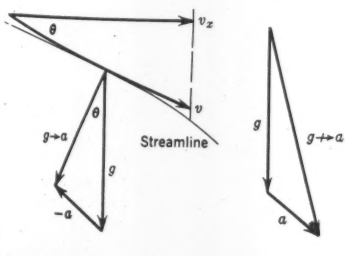
$$0 = \int_0^D (g \rightarrow a)V\cos\theta\, dy$$

$$\int_0^D (g \rightarrow a)v_x\, dy = \int_0^D g(V+v)\cos\theta\, dy \rightarrow \int_0^D a(V-v)\cos\theta\, dy$$

$$= \int_0^D g(V_x + v_x)dy \rightarrow \int_0^D a(V_x - v_x)dy$$

$$\approx \int_0^D 2g\, v_x\, dy,$$

FIG. 1



SOCIETY NEWS

AIChE Favors Pittsburgh for Engineering Societies Center

The Council of the American Institute of Chemical Engineers has indicated its definite interest in locating the proposed Engineering Societies Center Building in Schenley Park in Pittsburgh. However, while the AIChE Council, at its meeting in Dallas, Tex., on May 1, expressed itself as favorably disposed to the recommendation of the Committee of Five Presidents to locate in Schenley Park, it was not prepared to commit itself at that time.

It appointed Chalmer G. Kirkbride to act with appropriate representatives of the Four Founder Societies to encourage the Allegheny Conference on Community Development of Pittsburgh to proceed with development of a definitive plan for dealing with all the financial aspects of establishing the Center in Schenley Park.

The AIEE Board voted for the Pittsburgh site in April. ASCE, AIME, and ASME will take further action in June.

St. Louis Committee Makes Final Convention Plans

Success of the Society's St. Louis Convention is assured with St. Louis Section committees working long and hard to iron out all wrinkles. Meeting here for a planning session are (left to right) William J. Hedley, chairman of the Technical Program Committee; Brice R. Smith, general chairman of Convention committees; Clarence Ax, president of the St. Louis Section and a member of the General Convention Committee; and Stifel W. Jens, chairman of the Entertainment Committee. The program wll include more than twenty Technical Division sessions; study of the eagerly awaited findings of the Hoover Commission's Task Force Committee on Water Resources and Power; and tours of such local projects as the Lambert-St. Louis Municipal Terminal celebrated for its thin-shell dome construction. The full program appeared in May. The Jefferson Hotel will be Convention headquarters, and the dates are June 13–17.

Waterways Division to Have Local Section Representatives

In response to a long-expressed need for closer relationship between the Local Sections and the Technical Divisions, the Waterways Division has established a new organization of Local Section representatives. The first objective of the group will be to establish a constructive program of activities at Local Section level in the field of Division interests. A secondary purpose will be to provide support for the wide variety of activities conducted by the Division, and personnel for important committee assignments.

The new activity is being coordinated by a Committee on Cooperation with Local Sections, of which Samuel D. Stickle, of New York, is chairman. Other members of the committee are Norman R. Moore, of Vicksburg; Floyd D. Peterson, of Washington, D.C.; and John G. Turney, of Houston, Tex.

To date fourteen Sections or Branches of Sections have appointed representatives.

General Reimel Resigns As Secretary of EJC

The resignation of Brig. Gen. Stewart E. Reimel, M. ASCE, of Washington, D.C., as secretary of Engineers Joint Council has drawn from the Council a resolution of regret over his resignation and of appreciation of his "wise guidance and skillful diplomacy" in advancing the prestige of the organization. General Reimel will continue to serve as secretary of EJC's important Committee on International Relations.

E. Paul Lange, who has been serving as assistant secretary of EJC, will succeed General Reimel as secretary. A member of the AIME, Mr. Lang has engaged in mining engineering in Idaho, Alaska, and South America and served in World War II in the Army Counter Intelligence Corps. He is a graduate of the University of Washington.

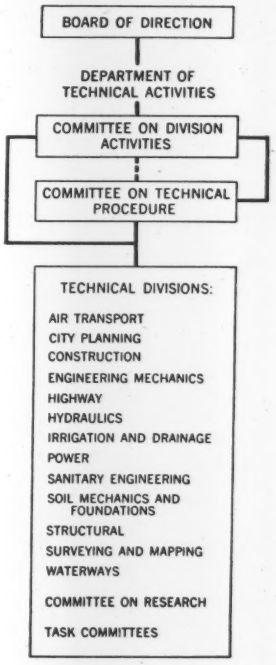
ASCE Administrative Structure—Department of Technical Activities

To give members a clearer understanding of the administrative structure of the Society, this page indicates the setup of the Department of Technical Activities—one of the two principal administrative branches. The organization of the other branch—the Department of Conditions of Practice—will be similarly depicted in an early issue. Enoch R. Needles, as Senior Vice-President, is chairman of the Committee on Division Activities and the Committee on Technical Procedure.

A lantern slide lecture that gives a comprehensive picture of the whole structure of the Society and its multitudinous activities has been prepared at the request of the Board of Direction. Copies have been sent to all Local Sections and Branches and all Student Chapter Faculty Advisers. A set of slides will be loaned from the headquarters office upon request to the Executive Secretary as the basis for talks at Local Section and Student Chapter meetings or Regional Conferences. The whole organization chart is shown in the Official Register, 1955, page 11.

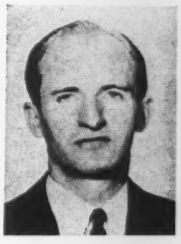
Photos of all the executive committee chairmen appear here, with the exception of C. C. Burger, Jr., Waterways Division chairman.

In Milwaukee on August 6 and 7 both the Technical Procedure Committee, and the Committee on Conditions of Practice will hold their meetings.

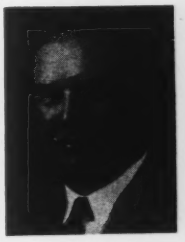


E. R. Needles
Chairman

R. H. Burke
Air Transport



C. A. Blessing
City Planning



C. D. Riddle
Construction

D. McHenry
Engineering Mechanics

R. E. Jorgensen
Highway

T. J. Corwin, Jr.
Hydraulics

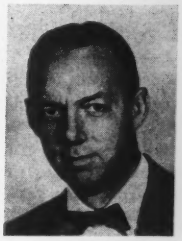
A. P. Rollins
Irrigation and Drainage

H. V. Lutge
Power

R. E. Fuhrman
Sanitary Engineering

W. J. Turnbull
Soil Mechanics and Foundations

G. E. Brandow
Structural



R. H. Lyddan
Surveying and Mapping

Elmer Timby
Research

Hydraulics Division Makes Plans for Berkeley Meeting

Hydraulics Division technical committees on Research, Design, Floods, and Hydrology have each prepared half-day technical programs for the Berkeley meeting of the Division, to which the San Francisco Section will be host August 24–26. These committee sessions will be preceded by a general opening program and followed by an inspection tour of the hydraulics laboratory facilities at the University of California.

The San Francisco area has many sightseeing attractions, and evenings will be free for exploration. First-time visitors to Berkeley are reminded that it is pleasantly cool in August, the normal daytime temperature being 62 deg F.

Meeting expenses are being held down by eliminating formal functions and by providing low-cost housing accommodations. The registration fee will be $2 for Members and Associate Members, nothing for Junior Members and students. A form for reserving accommodations will be printed in the July issue. Persons wishing to make reservations earlier should write General Chairman John K. Vennard for a discription and prices of accommodations. Professor Vennard's address is Stanford University, Stanford, Calif.

At work on plans for the Berkeley meeting of the Hydraulics Division are (left to right, seated): General Chairman John K. Vennard; Howard C. Wood, president of San Francisco Section; and Thornton J. Corwin, Jr., chairman of Division's executive committee. Standing, in same order, are David K. Todd, Wesley F. Getts, E. Neil Murphy, and Revoe C. Briggs.

Georgia Section Performs Useful Public Service

A hundred-million dollar crop loss in Georgia in 1954 due to a bad drought, the worst in 25 years, has stimulated the Georgia Section of ASCE to join with other organizations in giving the citizens and the legislature of the state the benefit of its professional guidance.

Representatives of 22 organizations interested in water in the state were called together in Atlanta last October by the Georgia Water Use and Conservation Committee to map a program of action, with B. M. Hall, Jr., representing the Georgia Section. Picking up the challenge the Section, at its all-day annual meeting on December 4, presented a six-part panel discussion on utilization and development of the water resources of the state. After a lively exchange of views, the Section concluded that a State Commission should be named to make a careful study of the physical needs related to water conservation and use in the state before any change is made in the present structure of the state's water law. This was step one. The statutes regarding water use in Georgia, which were adopted a century ago, are based on the doctrine of riparian rights taken from the English common law.

The Section met again on January 7, 1955, when a carefully drafted resolution carrying out the Section's recommendation was adopted, the resolution being directed to the Georgia Water Use and Conservation Committee. This was step two.

Step three was taken a week later when the Conservation Committee, by now consisting of representatives of 45 organizations including five engineering societies, adopted the recommendations of the Georgia Section, and directed the resolution to Governor Marvin Griffin and the Georgia General Assembly.

Steps four and five were taken on January 26, when the same resolution was presented to the Governor, and on March 3 when House Bill 46, creating a Georgia Water Law Commission, was approved by the Governor.

Some Southern states have revised their water laws to place the control of water in state-appointed boards of water engineers. This is the legal phase of the problem that the newly appointed Commission in Georgia will study.

The Georgia Section has a right to feel proud of its members and committees who were able to guide and direct the thinking and the actions of other organizations in the state toward this constructive legislative action. This is Local Section citizenship responsibility at its best. C. E. Drummond was president of the Section when the action was initiated.

ECPD Pamphlet on Public Speaking for Engineers

Availability of a second printing of its popular pocket-size manual, *Speaking Can Be Easy for Engineers, Too,* is announced by the Engineers Council for Professional Development. Organized for the convenience of the user in preparing and delivering talks, the two-color illustrated booklet points the way to better public speaking and better-conducted meetings. Among subjects covered are selecting the proper type of presentation, planning and preparation, attention-arousing techniques, good platform manners, visual aids, microphone techniques, effective chairmanship, introductions with a punch, handling the questions from the floor, and conduct of panel discussions.

Copies may be ordered from ECPD, 29 West 39th Street, New York 18, N.Y. They are 50 cents apiece, with special discounts for quantity orders of 100 or more copies.

ASCE MEMBERSHIP AS OF MAY 9, 1955

Members	8,900
Associate Members	11,426
Junior Members	70
Affiliates	70
Honorary Members	39
Total	38,313
(May 9, 1954	37,325)

From ASCE Student Chapters

Regional Student Conferences Stress Job Opportunities

Of increasing importance in Student Chapter operation are the regional Student Conferences held annually, and sometimes semiannually, in all parts of the country. Some of the conferences are held in conjunction with a Society Convention or Local Section meeting; others equally successful meet independently of any Society gathering. All have somewhat the same purpose—briefing senior-class students on career opportunities and preparing them for professional responsibilities.

This year two of the host Chapters to good conferences have reported.

North Central Conference

More than 200 representatives from Mid-Western Colleges were guests of the Michigan State College Chapter at East Lansing for a three-day conference at the end of March. One morning session featured a panel discussion on "The Future of the Graduate Engineer in Highway Development," with the speakers presenting possibilities in the federal, state, and local service and with the private highway engineer. The experts were George M. Foster, chief deputy commissioner for the Michigan State Highway Department; J. G. Schaub, local government engineer for the Michigan State Highway Department; Robert S. Scott, Scott Engineering Co., Alpena, Mich.; and Neil E. Macdougall, U. S. Bureau of Public Roads. Many of the questions from the floor were concerned with salaries.

Featured speakers at a general session devoted to promoting better Student Chapters were ASCE Director Lloyd D. Knapp and Allen P. Richmond. Assistant to the Secretary. Jennings Randolph, assistant to the president of Capital Airlines, addressed a joint banquet with the Michigan Section.

Tours of the Oldsmobile plant and of the Abrams Aerial Survey Corp. were other program highlights. The Abrams Corp. furnished a unique decoration for the banquet—"the world's largest photograph," a 10 by 60-ft aerial view of over thirty miles of highways. James M. Kelly and Harry R. Brasington were co-chairmen of the conference.

Upstate New York Conference

In the fall the Syracuse University Chapter was host to a weekend conference of delegates from Rensselaer Polytechnic Institute, Clarkson and Union colleges, and Cornell and Syracuse universities.

A symposium on "Job Opportunities for Civil Engineering Graduates" was the principal business of the conference. Taking part were A. S. Wikstrom, of the contracting firm A. S. Wikstrom, Inc., Skaneateles, N. Y.; C. E. Swain, division engineer for the Bureau of Public Roads' Division 1; J. Burch McMorran, chief engineer for the New York State Power Commission, Albany; and Oscar S. Bray, of Jackson & Moreland, Boston. Allen P. Richmond, of the Society's headquarters staff, addressed the annual banquet on "Collective Bargaining for Engineers."

Next year's conference will be held at Potsdam, N.Y., with Clarkson College the host.

Photo taken at one of University of Notre Dame Chapter's final meetings of year shows (left to right) Richard Meagher, vice-president; John Massman, president; James A. McCarthy, Faculty Adviser; Don M. Corbett, Director of the Society and guest of honor; James Sasso, treasurer; and Richard Brown, secretary. J. R. Cooper, of the Indiana Highway Department, gave the principal talk on the engineer in highway work. The Chapter reports an interesting and active year.

Bucknell University Student Chapter was host in April to the sixteenth annual conference of Student Chapters in the Philadelphia—Lehigh Valley—Delaware Sections. First-place winners in the student speaking contest, a long-standing annual feature, are (left and right in small view) R. M. Barr and E. S. Perry, of Princeton, with Faculty Adviser R. S. Rowe between them. The larger photo shows Mr. Barr again and some other student contestants: W. Schmidt, Drexel, seventh place; J. A. Hollingsworth, Jr., Lehigh, sixth place; H. Strachan, Swarthmore, fourth place; J. Hertzler, Bucknell, second place; Mr. Barr; J. H. Hayden, Lafayette, fifth place; and C. H. Gutberlet, Jr., Villanova, third place. Guests included ASCE Assistant Secretary E. Lawrence Chandler, who spoke on "Professionalism vs. Unionism," and ASCE Director Oliver W. Hartwell. Richard B. Ulp is president of the Bucknell Chapter.

Top brass at annual meeting of Rensselaer Polytechnic Institute Student Chapter, held in April, includes (in usual order) Prof. H. Oakley Sharp, who was honored upon completion of twenty years as Faculty Adviser; Edward Lansing, retiring Chapter president; J. Burch McMorran, chief engineer of the St. Lawrence Power Authority and principal speaker; and Admiral Lewis B. Combs, head of the civil engineering department and toastmaster. New Chapter officers, installed during the meeting, are James Miller, president; Peter Pugliese, vice-president; Stanley Moleski, secretary; and Henry Stearns, treasurer.

Student Chapters Honored for Excellence

President Glidden has announced the annual award to Student Chapters of 15 Certificates of Commendation and 52 Letters of Honorable Mention for activities during 1954. The winners of Certificates for superior work in 1954 and the number of times they have won top honors are the Chapters at:

Virginia Military Institute	(19th time)
Carnegie Institute of Technology	(13th time)
Iowa State College	(11th time)
Northeastern University	(10th time)
University of California (Berkeley)	(8th time)
Cooper Union	(6th time)
University of Dayton	(6th time)
University of Kansas	(5th time)
Georgia Institute of Technology	(4th time)
Missouri School of Mines & Metallurgy	(4th time)
University of Cincinnati	(3rd time)
North Carolina State College	(2nd time)
Oregon State College	(2nd time)
University of Washington, (Seattle)	(2nd time)
University of Maine	(1st time)

Letters of Honorable Mention go to Student Chapters at the following schools:

Alabama Polytechnic Institute
University of Alabama
University of Arizona
Bucknell University
California Institute of Technology
Case Institute of Technology
The Citadel
Clarkson College of Technology
Colorado Agric. & Mech. College
University of Colorado

Columbia University
University of Denver
Drexel Institute of Technology
Fenn College
University of Florida
George Washington University
University of Hawaii
University of Idaho
Kansas State College
University of Kentucky

University of Louisville
University of Maryland
Massachusetts Institute of Technology
University of Missouri
University of Nevada
University of New Hampshire
New York University
Newark College of Engineering
North Dakota Agric. College
University of North Dakota

University of Notre Dame
Ohio Northern University
Ohio University
Oklahoma Agric. & Mech. College
University of Oklahoma
Pennsylvania State University
Rice Institute
Rutgers University
South Dakota State College
Stanford University

Swarthmore College
Syracuse University
Agric. & Mech. College of Texas
Texas Tech. College
Texas Western College Branch
Tufts College
University of Utah
University of Virginia
State College of Washington
Washington University (St. Louis)
Wayne University
University of Wyoming

Three Certificates are authorized for award by the President in each of the five geographical regions into which the present 134 Chapters, two evening divisions, and four branch Chapters are divided for administrative purposes. By a change in the Bylaws recently voted by the Board of Direction, the number of letters of Honorable Mention, formerly limited to six per region, has been increased as determined by a formula devised by the Committee on Student Chapters and applied independently in each region. For activities during 1954, the number of letters varied from nine to twelve per region.

The formal scoring system used by the Committee on Student Chapters takes account of many different activities, each with appropriate weights. Final ranking and determination of winners is done by the Committee as a whole at its annual spring meeting, for recommendation to the President of the Society.

In the light of the very able efforts of leaders in the Chapters to provide interesting and worthwhile programs for their members, and the resulting close competition for the established awards, all concerned are to be congratulated for their accomplishments during 1954.

Senator Malone Addresses Univ. of Nevada Chapter

George W. Malone, U. S. Senator from Nevada, was among the attendance of seventy at the University of Nevada Student Chapter's annual banquet held in Reno on May 14. Senator Malone, who is an engineer and Member of ASCE, addressed the group briefly. ASCE Director Mercel J. Shelton was principal speaker, with a talk on "The Responsibilities of the Educated Man, Especially the Engineer." Another meeting highlight consisted of the presentation of the Section award of a Junior Member badge and first year's dues to Grant A. Engstrom as "outstanding Chapter member of the year."

New Chapter officers, installed during the evening, are Carlo Panicari, president; Jack Shevlin, vice-president; Joseph Triguiero, secretary; John Poppe, treasurer; and Eugene Wilkinson, correspondent for the Section's "Engineerogram."

St. Louis makes saving on paving

H. C. Halley, Standard Oil Asphalt Engineer (left), and C. G. Gilmore, St. Louis Acting Street Commissioner, observe 10-ton Buffalo-Springfield roller rolling final coat of STANDARD Asphalt Mix. H. C. Halley is an old hand at asphalt engineering. He has been providing technical service on asphalt application for nearly 30 years.

STANDARD

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(Indiana)

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IN SOUTH ST. LOUIS, the City Department of Streets and Sewers used STANDARD Asphalt to resurface a brick-paved thoroughfare.

In resurfacing this street, an initial leveling course of STANDARD Asphalt was laid down. This performed three important functions: (1) eliminated irregularities in the surface, (2) provided an even base for the finish coat, (3) provided a uniform thickness of the finish coat. Over this a three inch STANDARD Asphalt mix was applied.

St. Louis Department of Streets and Sewers availed itself of several important advantages when ordering STANDARD Asphalt:

Frank Kriz, St. Louis Director of Streets and Sewers, H. C. Halley and C. G. Gilmore (L. to R.) inspect leveling coat of asphalt mix, part of Compton Avenue resurfacing project.

1. It got a handy source of supply. There are five Midwest shipping points for STANDARD Asphalt, one of them only a few miles from St. Louis.
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You can get these advantages when you buy asphalt from Standard. Find out. In the Midwest, call your nearby Standard Oil office. Or contact Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

CH 597

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

H. Glenn King, of Phoenix, was named the outstanding member of the University of Arizona Student Chapter at the **Arizona Section's** all-day spring meeting, held in Tucson on April 23. Mr. King and his fellow students, Roger Stephenson and Thomas Difloe, presented a symposium on flood control problems on the lower Mississippi. Other speakers included E. J. Workman, president of the New Mexico Institute of Mining and Technology; Norman H. French, of the Arizona Soil and Moisture Conservation Branch of the Soil Conservation Service; Dwight H. Rutledge, assistant regional engineer for the Topographic Division of the U.S. Geological Survey; John Tsaguris, planning engineer for the Tucson-Pima County Planning Department; and John Park, dean of the University of Arizona College of Engineering.

Featured speakers at recent meetings of the **Central Illinois Section** have been W. W. Wallace, district engineer for the Portland Cement Association, who described the general objectives of the Association's research and education programs, and Frank W. Edwards, of the Stanley Engineering Company's Chicago office, who discussed the St. Lawrence Seaway Project. Mr. Edwards stressed the economic implications of the seaway, which will bring Chicago and other lake cities some 600 to 800 miles closer to European ports.

Festive gathering in Sao Paulo, Brazil, honors Clyde M. Wood (third from left, front row), who received his certificate of life membership at this meeting of the Brazil Section. Featured speaker was Camilo de Menezes, director of the Departamento Nacional de Obras de Saneamento, whose subject was river flow regulation.

Mexico Section elected new officers at its annual dinner meeting on March 24, which was also Ladies' Night. Officers are (in usual order) Guillermo Salazar Polanco, retiring secretary; Earle S. Sloan, president; Armando Santacruz, past-president; Miguel Montes de Oca A., secretary-treasurerer; and Francisco J. Serna-Baylor, vice-president. Seated are George D. Camp and Mrs. Sloan. Mr. Santacruz, who is retiring as president, made a gift to the Section of an ASCE banner.

A positive program of encouragement for Junior Members to remain in the Society when confronted with the age deadline for transferring to Associate Member grade or dropping out (as do 65 percent of these members) was outlined by ASCE Director Don Corbett in a talk on Society activities that highlighted a recent meeting of the **Cincinnati Section.** Bill Zachman moderated the Daniel V. Terrell Award Competition, in which four Junior Members read essays. Baxter Napier was the winner.

A panel of Case Institute Student Chapter members—George Rowley, Ronald Bogolin, and Dean Pappas (president)—put on an interesting program of papers at the **Cleveland Section's** April meeting held at Case on the 26th. The Section's award of a year's dues as Junior Member was presented to Mr. Pappas as the outstanding member of the Case Chapter. Ted Stumphauser was similarly honored as outstanding member of the Fenn College Chapter.

The extremely varied engineering services required of the North Pacific Division of the Corps of Engineers was emphasized by Division Engineer Louis H. Foote at the April meeting of the **Columbia Section**—a joint session with the Yakima Engineers Club. The variety of these services underscores the need for continually expanding our sources of new engineering talent to meet new challenges, Colonel Foote said.

Members of the Student Chapter at Utah State Agricultural College were in charge of the program at the **Intermountain Section's** March meeting, held at Logan on the 31st. Guest speaker Allan Johnson, manager of the Atomic Energy Commission's Arco, Idaho, development, dealt interestingly with problems arising in the design and construction of the materials-testing reactor and the protective devices against radiation employed at the plant.

In a double header put on by the **Iowa Section** and the Iowa City Engineers Club in Iowa City on March 29 Col. D. A. Richards, district engineer of the Omaha District of the Corps of Engineers, and Jack A. Gardner, of the District's Planning and Reports Branch, were featured speakers. Their subjects were engineering leadership and planning for the Missouri Basin main stem projects.

Prof. John Reps, of the Cornell University School of City and Regional Planning, was principal speaker at a recent joint meeting of the **Ithaca Section** and the Cornell University Student Chapter. His subject was "Urban Renewal." For its April meeting the Section joined with the Southern Tier section of ASME to hear Robert T. Knapp, professor of hydraulic engineering at the California Institute of Technology and director of the hydrodynamics laboratory there, in one of a special lecture series sponsored by ASME. Dr. Knapp spoke on cavitation.

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M. E. Norman and R. R. Ritchie, outstanding civil engineering students at West Virginia University and members of the ASCE Student Chapter there, are winners of West Virginia Section prize of $15 each for first year's dues as Junior Members. Presentation was made at the Section's April dinner meeting in Clarksburg, at which the Section was host to the entire Chapter.

The **Kansas Section** voted to buy Student Chapter banners at $25 each for the groups at the University of Kansas and Kansas State College at its March 18 meeting. Other get-together devices discussed at the meeting were father-son banquets, field trips, etc. The featured speaker was L. M. Van Doren, of Servis, Van Doren and Hazard, who outlined construction problems arising in expansion of Forbes Air Force Base.

Air conditioning as it affects our utility systems was the subject of a symposium presented at the **Kansas City Section's** April meeting. The speakers were Glenn Stoffer, district manager of the Carrier Corporation; Joseph S. Palmer, system planning engineer for the Kansas City Power and Light Company; and Melvin P. Hatcher, director of the Kansas City Water Works. Members of the Kansas University Student Chapter were guests of the Section. Section boundaries have been changed to make Wyandotte and Johnson Counties, formerly in the Kansas Section, part of the Kansas City Section. In the December issue it was erroneously stated that the new setup placed these Sections in the Kansas Section.

Student Chapter members in the Baltimore area were featured speakers at the **Maryland Section's** March meeting. In a talk on "Creativity in the Engineer," Mark Schweizer, of the University of Maryland, captured the attention of the audience with a challenge to the profession to develop unity of design in structures. Robert L. Potter, of the Johns Hopkins University, spoke interestingly on night visibility and its effect on driver performance. The student engineers, who were present in great force, were told of the opportunities in store for them as civil engineers "in a nation on the verge of tremendous expansion in highway construction and general building" in informal talks by ASCE president W. R. Glidden and Section President W. L. Chilcote.

This year Metropolitan Section honors go to ASCE Honorary Member Shortridge Hardesty, who has been named "Metropolitan Civil Engineer of the Year" in the third annual award of this distinction. Widely known as a consulting engineer, Mr. Hardesty was specifically honored for his work on the Harlem River Bridge, the New York Central's twin vertical-lift structure still under construction and hailed as "an outstanding contribution to the science of bridge design." Mr. Hardesty is cited by the Section as "A distinguished engineer whose exceptional ability, founded on broad experience and continuing inquiry, has enabled him to conceive and direct the design of major structures, particularly bridges, and whose accomplishments have brought credit and public appreciation to the civil engineering profession."

The emphasis was on students at the **Miami Section's** April meeting, with three members of the University of Miami Chapter presenting papers in a competition. The $25 prize went to Stanley W. Hole for a paper entitled "Ethics of Competitive Sealed Bids for Professional Services." Guest speaker Norman Bean discussed "Flying Saucers."

The **Mid-South Section** was host to the District 14 Council during its annual spring meeting in Vicksburg, Miss., April 14 and 15. The perennial problem of regulating the Mississippi came in for attention in the major technical talks, with Frank G. Meek, chief of the Project Branch, Vicksburg District, Corps of Engineers, speaking on "Willow Control in Yazoo Basin"; Brig. Gen. John R. Hardin, president of the Mississippi River Commission, discussing the Mississippi-Atchafalaya Diversion; and Norman R. Moore, chief of the Engineering Division, Mississippi River Commission, presenting the topic, "Design of Structures for Old River Control." The Council endorsed the Section's action in naming former Director Norman R. Moore its choice for Vice-President for Zone III, subject to ratification by the various Sections in the Zone. The Council's officers for the coming year will be John I. Parcel, of St. Louis, chairman; Sydney W. Chandler, of Jackson, vice-chairman; and J. Kent Roberts, of Rolla, Mo., secretary.

The **Nebraska Section** needs only formal Board authorization to put into operation a Southwest Branch with headquarters at McCook. Featured speaker at the Section's April meeting was H. E. Prater, regional engineer for the Bureau of Reclamation at Denver and secretary of the executive committee of the Irrigation and Drainage Division. Mr. Prater discussed Division activities.

A successful spring meeting is reported by the **New Mexico Section.** Held at White Sands Proving Ground and New Mexico A & M College, April 15 and 16, the program began with a conducted tour

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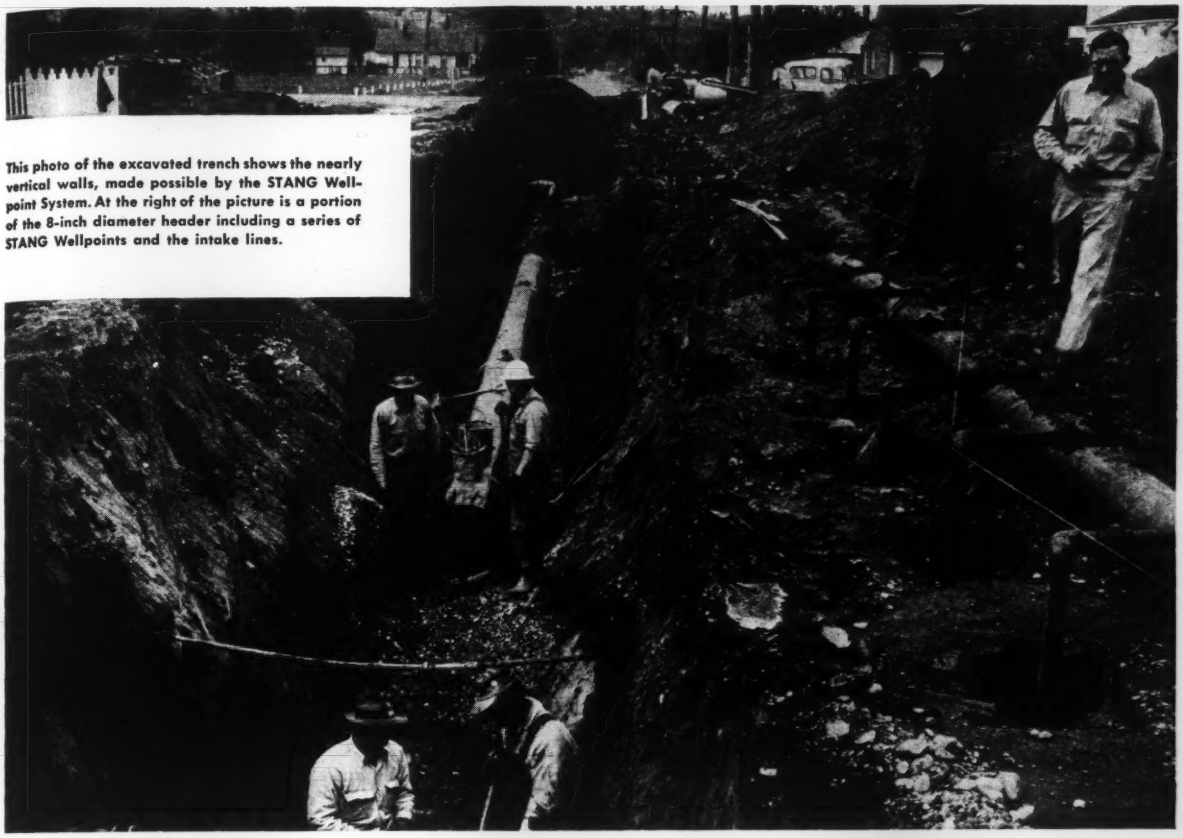
Shown at joint meeting of Maine Section and Maine Association of Engineers are (left to right, front row) E. Lawrence Chandler, Assistant Secretary of ASCE; Lucius D. Barrows, president of Maine Section; and Willard J. Strout, president of Maine Association of Engineers. Standing, in same order, are Weston S. Evans, chairman of Section's Program Committee; Gerald Mayberry, in charge of arrangements for meeting; Horace A. Pratt, secretary of Maine Association of Engineers; and Herman J. Burgi, general manager and treasurer of Portland Water District. Messrs. Burgi and Chandler were the speakers.



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These are shots from the Tennessee Valley Section's spring meeting, to which the Knoxville Subsection was host on May 6. Viewed at the luncheon meeting during President Glidden's talk are (left to right) Henry C. Peeples, president of Chatanooga Subsection; Roy J. Morton, president of Tennessee Valley Section; President Glidden; J. E. Griffith (behind lectern), president of Knoxville Subsection; and ASCE Director Graham P. Willoughby. The young men at the right are, in usual order, Robert N. O'Brien, of Knoxville, and Robert H. Roth, of Clarksville, winners of the Section's annual award for the two outstanding senior students in the University of Tennessee Chapter. Awards consist of the payment of first-year dues as Junior Members.

of the Proving Ground facilities, including equipment for tracking rockets in flight and a special underground structure for missiles. The Proving Ground facilities were explained in the after-dinner talks—by Ben Billups, who showed and explained devices that have been developed there for measurement of gravity deflections, and Lt. Col. John P. Stapp, who discussed "Biodynamics of Human Factors in High Speed Transportation" and showed films of rocket test sleds and experiments. In one ride on a rocket sled Colonel Stapp attained a velocity of 632 mph. Winners in the student paper contest were Art Anstine, of the University who received first prize ($25 and a year's subscription to CIVIL ENGINEERING); Ed Foreman, of New Mexico A & M College, second prize ($15 and the 1954 Transactions); Gayle Erickson, of Texas Tech, third prize ($10 and six manuals of engineering practice); and Jim Holt, of Texas Western College, fourth prize ($10 and six manuals of practice).

Section President Gordon Herkenhoff

Plans under consideration for the port of Portland were outlined by John J. Winn, Jr., at the **Oregon Section's** April meeting. These include expansion of the Portland airport and development of Swan Island for industrial purposes including ship-repair facilities.

Soil tests were interpreted for the benefit of **Pittsburgh Section** members attending the April meeting by Section Vice-President Elio D'Appolonia, who is also associate professor of civil engineering at Carnegie Tech. Dr. D'Appolonia's talk emphasized practical applications in the construction field. The **Junior Branch** meeting, on April 7, featured talks on evaluation of unionization for engineers by Howard Sturdy, vice-president of the Dravo Corp., and E. X. Hallenberg, assistant director of the Westinghouse Research Laboratory.

In April the **San Francisco Section**—the Society's No. 1 Section in point of years—celebrated its fiftieth anniversary. It started out on April 28, 1905, with the name "San Francisco Association of Members of the American Society of Civil Engineers," which in 1920 became "San Francisco Section, American Society of Civil Engineers." From a membership of 65 in 1905, the Section has grown until it now has over 1,100 dues-paying members (only half the present potential membership, the Section notes).

Proposed state legislation affecting engineers was summarized at the March meeting of the **San Antonio Branch** of the **Texas Section** by Robert L. Lowry, Jr., Austin consultant and president of the Texas Section. At the Branch's April meeting H. D. Pfannkuche, of the Fort Worth office of the Portland Cement Association, spoke on recent developments in prestressed concrete.

Earthmoving equipment was reviewed at the **Toledo Section's** April meeting by Doyle C. Reynolds, of the Caterpillar Tractor Company's Earthmoving Development Section. A supplementary film entitled "The Big Track" showed the development of equipment from 1800 to the present.

The **Wisconsin Section** has initiated a newsletter, which will be issued whenever there is an accumulation of news to share.

Coming Events

Maine—Joint meeting with the New Hampshire Branch—field inspection of new Portsmouth Air Force Base, August 27.

Nebraska—Meeting at Grand Island, October 22.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

San Francisco—Regular meeting at the Engineers Club, June 21. Section will be host to a Hydraulics Division Convention, August 24–26.

Wisconsin—Meeting of the District 7 Council at the Pfister Hotel, Milwaukee, August 5–6.

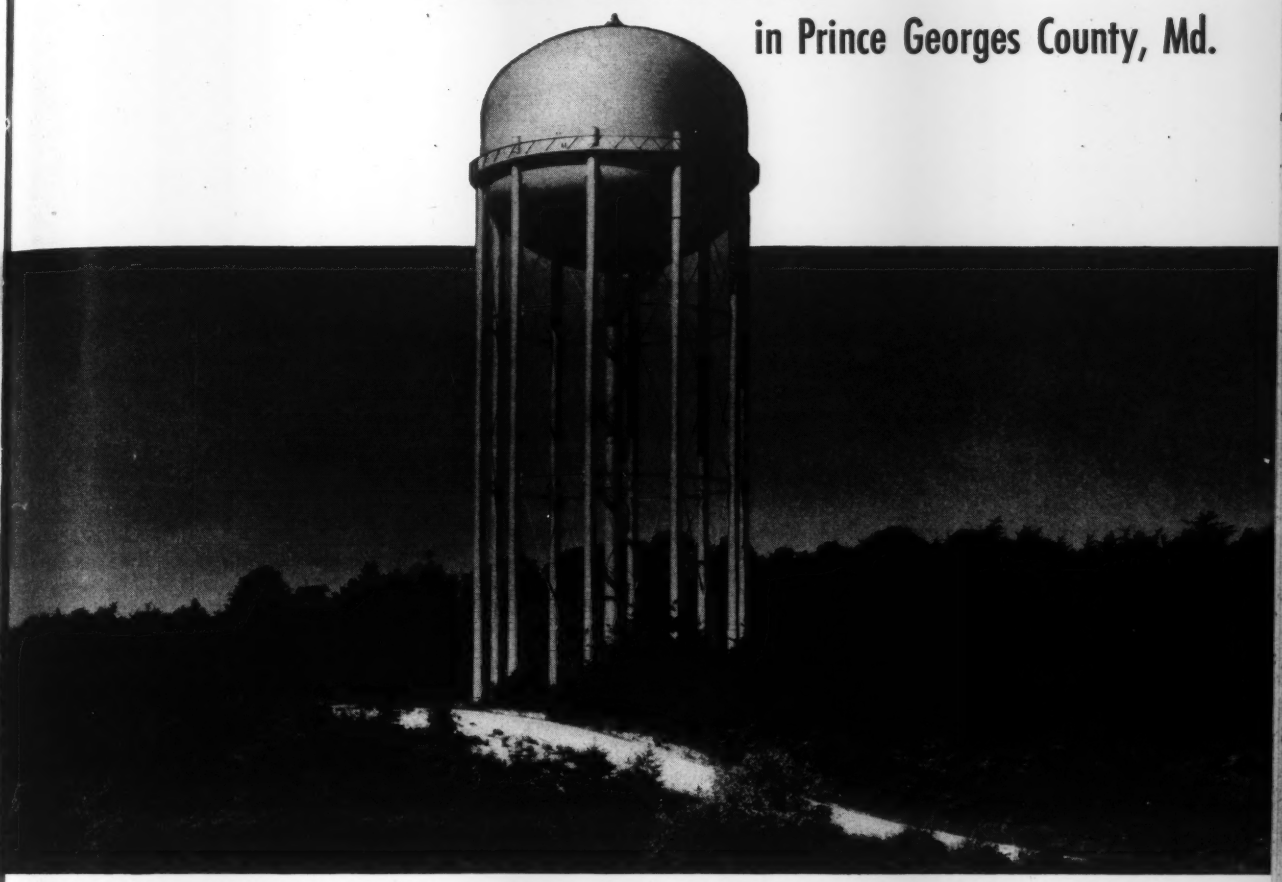
Scheduled ASCE Conventions

ST. LOUIS CONVENTION
St. Louis, Mo.
Jefferson Hotel
June 13–17, 1955

NEW YORK CONVENTION
New York, N. Y.
Hotel Statler
October 24–28, 1955

DALLAS CONVENTION
Dallas, Tex.
Hotel Baker
February 13–17, 1956

Water rides on a tall tower for better consumer service in Prince Georges County, Md.



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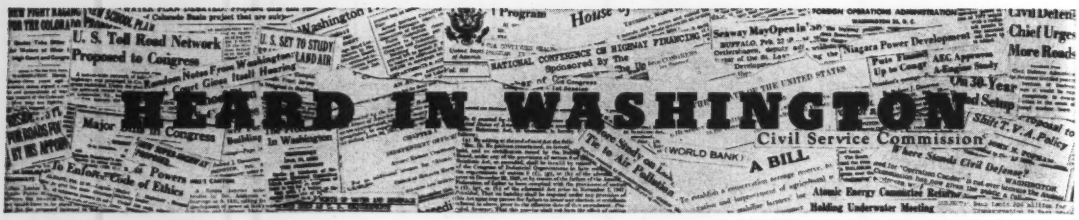
HEARD IN WASHINGTON
U. S. Toll Road Network Proposed to Congress
U. S. SET TO STUDY LAND AIR
Civil Service Commission
A BILL
Chief Urges More Roads

JOSEPH H. EHLERS, M. ASCE — Field Representative ASCE

National Highway Legislation

The event of the month in Congress, as far as the engineering profession is concerned, is the struggle to enact national highway legislation bearing some resemblance to President Eisenhower's "grand plan" which would provide a new Interstate Highway network during the next ten years. The bill reported to the Senate, which will be voted on by the Senate late in May, omitted many salient features of the President's plan as developed by the Clay Committee.

The ASCE Committee on a National Highway Program presented testimony to the Senate Subcommittee on Roads of the Committee on Public Works and House Committees on Public Works. Because of its importance to the Society that testimony is being summarized in excerpts, as follows:

Priority for the Interstate System

"We have little doubt as to the importance of giving the Interstate System by far the highest priority in the finance plan. A system which carries over 14 percent of all our highway traffic on 1.2 percent of its mileage, a traffic movement twelve times as great as the average on the total road network, and which connects 90 percent of all our cities of over 50,000 population, where most traffic has its origin or destination, should be of far greater federal interest than other parts of our national highway system. We believe that support should be continued on the other systems at least at present levels.

Standards

"Because of the high ratio of earning value per vehicle and its priority, the measurement of needs on a ten-year completion basis seems fully warranted. The values of control of access on major arteries have been fully demonstrated. There is no other way by which we can step up transportation service to the required level in terms of freedom of movement, time saving, lives saved and lowered vehicle-operating cost and preserve those values for posterity.

Shortage of Engineers

"Further augmentation of the highway programs will require attention to manpower factors, inasmuch as it appears that the total pool of professional highway engineering manpower will not be greatly increased in the next few years. . . . We, therefore, affirm the ability of the Civil Engineering profession to meet the demands.

Postponement of Financial Burdens by Bond Issues

"We believe that costs to the next generation will be less than if lower standards were to be adopted now and the added width needed in ten to fifteen years had to be provided by purchase of added right-of-way and probable relocation of much of the road.

"We believe that traffic induced by the new system will produce additions to revenue income that would not otherwise be available. Operating highways generate money income in proportion to vehicle usage; thus in effect there is a contribution into the public coffers for each vehicle mile traveled whether a toll gate spans the highway or not.

Credit for Toll Roads

H.R. 4260 provides for a credit of 90 percent of the cost of a future toll road. This would be allowed to the state as a fund which might be used for other federal-aid roads. This provision is very controversial, and many Congressmen have indicated that no credits should be allowed. The bill reported by the Senate Committee contains no credit provision. The ASCE Committee in testimony to be presented to the House Committee suggests a compromise.

"If the contribution of the federal government were to remain at 60 percent as at present or even increase to some higher ratio, possibly 75 percent, there would still be an incentive for states to provide toll roads which would support themselves. It can be demonstrated that if no credit is to be given for toll roads and the federal government is to provide as much as 90 percent of the cost of the Interstate System, no state will authorize the construction of a toll road.

"In the ordinary bond issue based on toll revenues, the debt will be retired in a twenty-year period at which time with the retirement of the bonds the toll road is presumably free. It is suggested, therefore, that the credit which should be allowed to the state should be in the order of the present worth of the depreciated value of the toll road twenty years hence (about 25 percent of the cost) to allow for periods of possible decreased revenues due to gasoline rationing or other restrictions during the twenty-year period, the credit allowed might be somewhat higher. It is therefore suggested that the credit for toll roads should be between a quarter and a third of the construction cost thereof.

"It is a matter of arithmetic that if a state can successfully finance toll-road projects on the basis of a credit of 25 percent, that the same amount of contribution by the federal government will produce four miles of road, whereas if there were to be no credit whatever for the toll road the federal government investment would produce only one mile. In order to get the most mileage for the Interstate System with the least investment of public money, the credit provision should be such that sound toll road project are not eliminated, and unsound projects not encouraged."

The ASCE Committee on National Highway Program consists of Carleton S. Proctor, Chairman, George E. Burpee, Harmer Davis, Edmund Friedman, and Ralph A. Tudor.

Washington, D.C.
May 20, 1955

[The Senate passed the Gore Bill on May 25. The ASCE Committee appeared before the House Committee on Public Works on June 1.]

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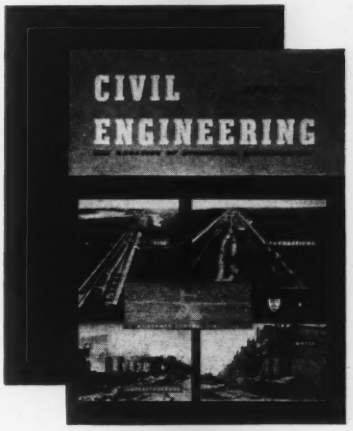

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NEWS BRIEFS . . .

ASME Holds Diamond Jubilee Spring Meeting

Papers presented at the Diamond Jubilee Spring Meeting of the American Society of Mechanical Engineers, held in Baltimore the week of April 18, offered proof of rapid progress in the practical application of atomic energy for the generation of power. The subjects discussed included the basic materials used and the metallurgical problems involved in nuclear power plants, with D.O. Leeser, of the Detroit Edison Company's Nuclear Power Development Department, giving an overall presentation of the basic materials available for nuclear-fueled power plants and the problem of balancing cost with technical and design specifications.

The growing trend toward engineering specialization was defended by Granville M. Read, chief engineer of E. I. du Pont de Nemours & Co., who has done much to develop the latest area of such specialization—atomic energy. Mr. Read, who was in charge of design and construction of the Hanford Engineer Works for the production of plutonium, said: "We hear sometimes that this is an age of overspecialization. While I agree that engineers should be well-rounded men, an integrated engineering effort demands specialized knowledge in a great many specific engineering fields." He added, "We never regiment engineers into a specialty, for we know through experience that this has been ineffective. I don't believe regimentation will work even in Russia."

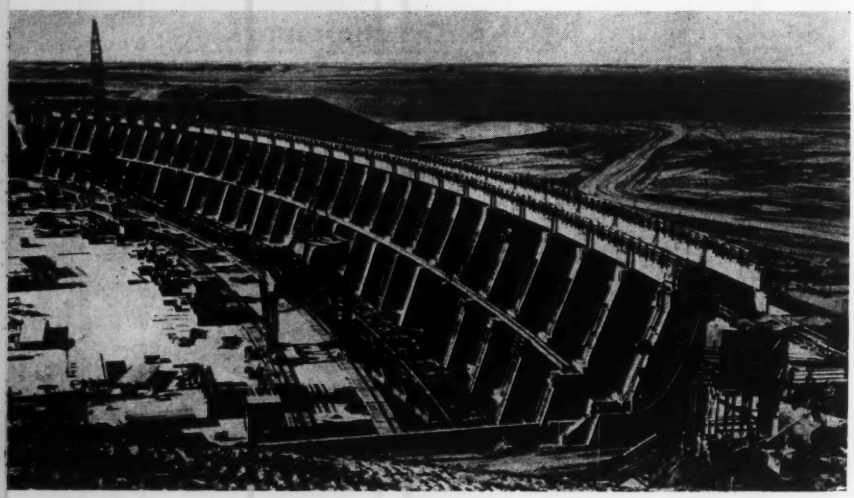
Mr. Read's talk was part of a three-man panel on the theme, "The Engineer and the Prospects for Peace." John Bell Rae, associate professor of history at M.I.T. and another speaker in the panel, predicted that the present-day engineering graduate has about one chance in two of moving into management. Referring to a study he is currently conducting on the engineer as a businessman in the United States, he said "One of the significant factors which has emerged is that during the past half century there has been a steadily increasing flow of engineers into positions of executive responsibility in industry." Dr. Rae stressed the need for an extension of the professional integrity of the engineer into other fields. He said, "There is an underlying philosophy that making a fast buck is not really a desirable goal in life; that what counts is delivering an honest product, whether it be an automobile or an international treaty, whose performance will live up to its promise."

Russian-born Dimitri Shimkin, a social science analyst with the Department of Commerce and third speaker in the panel, noted that the Soviet Union increased its industrial output more than eightfold in the quarter-century between 1928 and 1953, and has doubled its industrial man-hour productivity since 1928. In spite of these advances, he said, the volume of manufacturing and mining in 1954 was only about 35 percent of that of the United States. Chairman of the panel was Walker L. Cisler, president of the Detroit Edison Co., Detroit, Mich.

In another timely paper John S. Attinello, head of the supersonics section of the Navy Bureau of Aeronautics, expressed the opinion that low-speed landing coupled with thrust reversers may soon eliminate the need for special landing fields with long runways. Mr. Attinello described pilot-controlled diversion of aircraft power from thrust to lift, and vice versa, to assist aircraft during takeoff and landing.

More than 1,000 engineers attended the week-long meeting, one of a series marking the ASME's seventy-fifth anniversary. The meeting theme was "The Engineer and the World of Government." David W. R. Morgan, vice-president of the Westinghouse Electric Corp., Pittsburgh, is president of the ASME this year.

Work on Garrison Dam Spillway Nears Completion



Work on Garrison Dam spillway, part of the largest earth-filled dam embankment in the world, is scheduled for completion in August. A key feature in the Pick-Sloan plan for development of the Missouri Valley, Garrison Dam is a Corps of Engineers project under construction across the Missouri at Riverdale, N. Dak. It is 2½ miles long and 2,600 ft wide at the base. The spillway will incorporate 282,000 cu yd of concrete and 12,000 tons of reinforcing steel and other metals. Each of its 28 gates weighs 50 tons and is 40 ft wide and 29 ft high. Though over 500 men are employed on the spillway, the low accident rate won the builder, Garrison Spillway Constructors, an AGC plaque in 1954 for top safety honors in the Heavy Construction Division. Early construction stages of the project were described by J. S. Seybold in the October 1949 issue.

Ohio Valley Sanitary Group Advises Industry

Speedier progress in the control of pollution from industrial sources was predicted by W. W. Jennings, chairman of the Ohio River Valley Water Sanitation Commission, in a recent report to the governors of the eight states signatory to the Ohio Valley sanitary compact. Mr. Jennings transmitted a statement on policy and procedure formulated as the result of a two-year study by the Commission and its 150-member industry-action committees.

The policy provides that requirements for the modification or restriction of industrial-waste discharges shall be designed to maintain water uses that will best serve the public interest. Certain basic restrictions, applying to all types of industrial waste discharge, are stipulated. The restrictions uphold a statutory provision in the Ohio River Valley interstate compact that all waters are to be "free from unsightly or malodorous nuisances due to floating solids or sludge deposits."

Recommendations for additional control measures will be based on studies now under way involving separate investigations of each industrial plant and the stretch of stream on which it is located.

Canada's Second Largest Bridge Opened to Traffic

New Angus L. Macdonald Bridge, opened to traffic in April, spans Halifax Harbor, linking Halifax and the town of Dartmouth. With a center span of 1,447 ft and total length of 5,290 ft, the structure is the second largest suspension bridge in the British Commonwealth ranking next in size to the Lions Gate Bridge in Vancouver. It has a 27-ft roadway and 5-ft sidewalk, plus such unusual features as provision for carrying a 30-in. water main from the Dartmouth side of the harbor when the city outgrows its existing supply. The Dominion Bridge Company, Ltd., was the prime contractor for the superstructure and responsible for the erection and fabrication of the steel. P. L. Pratley, M. ASCE, of Montreal, was the consulting engineer and C. A. Fowler, of Halifax, associate engineer. P. G. A. Brault, of Montreal, was project engineer for the Dominion Bridge Company. Photo courtesy of the Dominion Bridge Company.

Congress Names Panel on Peacetime Uses of Atom

All phases of the effect of peacetime applications of atomic energy in the United States will be studied by a special eight-man panel of experts recently named by Congress. Robert McKinney, editor and publisher of the *Santa Fe New Mexican* and former Assistant Secretary of the Interior, is chairman of the group, which includes two ASCE Members—Director Samuel B. Morris, general manager and chief engineer of the Los Angeles Department of Water and Power, and George R. Brown, member of the Houston, Tex., construction firm, Brown and Root.

Others on the panel are Ernest R. Breech, chairman of the board of the Ford Motor Co., Detroit; Sutherland C. Dows, president and chairman of the Iowa Electric Light and Power Co., Cedar Rapids; John R. Dunning, dean of engineering at Columbia University and director of the Oak Ridge Institute of Nuclear Studies; Frank M. Folsom, president of the Radio Corporation of America; and T. Keith Glennan, president of Case Institute of Technology and former member of the AEC.

The committee will be asked to "appraise the present and future impact of peaceful applications of atomic energy on the American way of life. . . ."; consider the impact of such applications on economics and industries abroad as well as on our own domestic economy; study the activities of the AEC as they affect the foregoing program; and recommend legislative and policy actions needed to speed development of peaceful uses of the atom.

A similar panel was appointed about a year ago to study military uses of the atom.

Building Industry Asked to Aid Korean Homes Project

A plea to the building industry of the United States to sponsor a "Homes for Korea" Project has been received from the American Korean Foundation. Aimed at showing the Koreans how to meet their critical housing needs through mass production of the kind of homes that fit their way of life, the project will be carried out by the Koreans themselves who will construct model villages under American supervision with materials furnished by United States builders. Plans call for building a minimum of 1,000 homes which will require donations of some $1,500,000 in materials and money from the industry.

Gen. James A. Van Fleet is honorary chairman of "Homes for Korea." Co-chairmen are William Zeckendorf, president of Webb and Knapp, Inc., and Earl Smith, president of the National Association of Home Builders. Brig. Gen Richard S. Whitcomb is executive director. Inquiries should be addressed to Mr. Zeckendorf at Webb & Knapp, Inc., 383 Madison Avenue, New York 17, N.Y.

Asphalt Institute Opens Its New Laboratories

Better roads, not more of them, is the immediate highway problem in the United States, guests at the dedication, on May 5, of the new Asphalt Institute headquarters on the University of Maryland campus were told. The speaker, former Congressman Jennings Randolph, now assistant to the president of Capital Airlines and official of the American Road Builders Association, pointed out that the nations's rural road system has changed very little in length since the end of World War I when it totaled about 3,000,000 miles.

Mr. Randolph, who served fourteen years on the House Roads Committee before entering private industry, observed that only 919,000 miles—less than one-fourth—of the nation's 3,336,000-mile highway network are paved. He mentioned a Department of Commerce prediction that our highway system will change very little in length in the next fifteen or twenty years but that a major overhaul and modernization program is surely needed. "Tomorrow's highways are being built in the laboratories today," he declared.

Mr. Randolph sounded the keynote in a dedication program that saw Judge William P. Cole, Jr., chairman of the university's Board of Regents, formally turn over the new Asphalt Institute building to J. E. Buchanan, M. ASCE, president of the Institute. President Wilson H. Elkins, of the university, presided at the exercises in the university armory.

Difficult Site Complicates Hartford Library Project

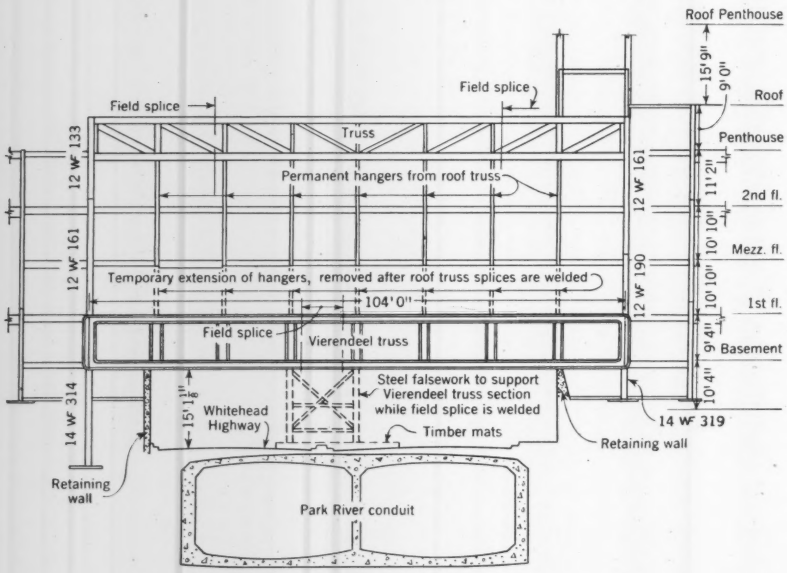
The site selected for the new Hartford, Conn., public library, an all-welded structural steel building now under construction, posed unusual problems that were solved by use of an unusual design. It was required to erect the library over a six-lane highway, which is built above a twin conduit through which the Park River flows. Two-lane highway travel in each direction had to be maintained during construction.

The building design chosen features the use of five Vierendeel trusses, two of them believed to be the largest and heaviest trusses of the type ever fabricated and erected in the United States. An important advantage of this type of truss is that the open spaces provide more book-storage space in the library basement.

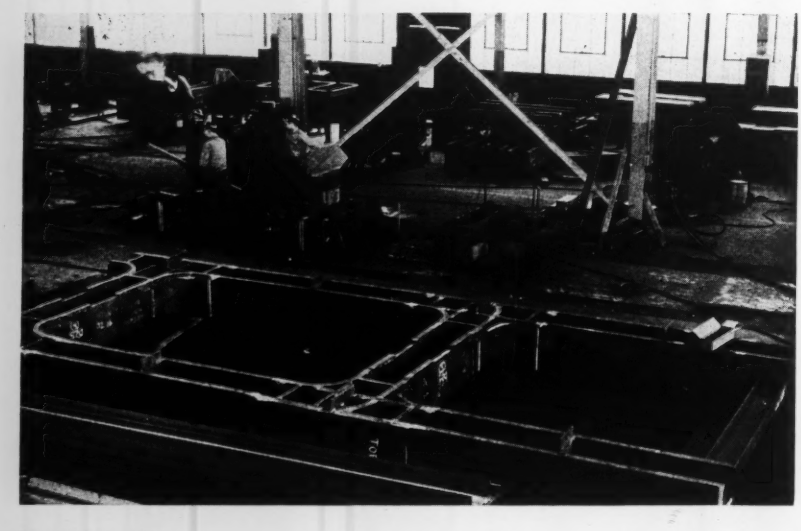
Two of the Vierendeel trusses have a 104-ft span and weigh 94 tons each; two have a 91-ft span and weigh 73 tons; and one has a 91-ft span weighing 53 tons. These trusses alone required 44 miles of deposited weld metal in the shop and in the field ($\frac{1}{4}$-in. equivalent fillet weld). They were shipped by rail from the Allentown, Pa., plant of the fabricator, the Lehigh Structural Steel Co., and trucked to the job site.

In addition to the Vierendeel trusses, the structure also required ten conventional roof trusses, from which depend hangers supporting the mezzanine and second floors leaving the first floor unobstructed by columns.

The general contractor on the project is the Wadhams & May Co., Hartford. Robert Loomis, of Windsor, Conn., is the structural engineer, and Schultz & Goodwin, of Hartford, the architects. Daniel Tasillo was supervising architect for the city. Steel erection is by the Lehigh Construction Co., a subsidiary of Lehigh Structural.



Site of the Hartford public library over a six-lane highway, built above a twin conduit through which the Park River flows, is indicated in the sketch. Foreground of the photo, taken in the Allentown shops of the Lehigh Structural Steel Co., shows the huge size of a completed panel for one of the five Vierendeel trusses employed on the project. In the background are straight sections, fitted tee sections, and a fitted I-section.



Bids for Barnhart Island Powerhouse

Results of bidding for the construction of the United States half of the Barnhart Island Powerhouse, a key structure in the St. Lawrence Power Project, are announced by the Power Authority of the State of New York. Six bids were received, ranging from a low of $36,229,760 to $43,709,000. The low bid was submitted by the joint venture of Merritt-Chapman & Scott Corp. and the Savin Construction Corp.

The contract is for a reinforced concrete gravity structure with a maximum height of 160 ft above the foundation and overall length of 3,130 ft, equally divided between the United States and Canada by the International Boundary Line. The power plant will be of the modified outdoor type housing sixteen units, with the erection bay, control room, offices, and miscellaneous shops enclosed in a metal, masonry, and glass building.

Three Contractors Share Newfoundland Airbase Job

Award of a joint $10,755,900 low-bid contract for construction of additional airbase facilities at Argentia, Newfoundland, is announced by the Navy Bureau of Yards and Docks. The winning combine consists of the Merritt-Chapman & Scott Corporation and Johnson, Drake & Piper, of New York, and the Ayers, Hagan & Booth Construction Company, of Providence, R.I. The Argentia Naval Air Station was built during World War II.

April Construction Activity at New High for the Month

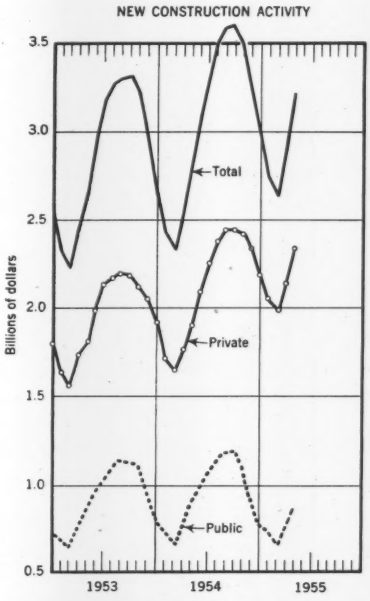
Outlays for new construction rose seasonally this April to a new high for the month of $3.2 billion, and approached a record total of $11.6 billion for the first four months of the year, according to preliminary estimates prepared jointly by the Departments of Commerce and Labor. After allowance for seasonal changes construction expenditures during the month had risen to the unprecedented annual rate of nearly $41^2/_3$ billion—in comparison with an annual rate of $40^1/_2$ billion during January 1955, and actual outlays of $37.2 billion in 1954.

Activity thus far in 1955 was at a new peak for private residential buildings, commercial buildings, schools (private and public), churches, sewer and water facilities, public utilities, and highways. Commercial building also set a new monthly record in April. Increases during the month were about seasonal for most types of construction. However, private industrial building, which has shown a spring decline in recent years, remained steady. Construction of military facilities rose less than usual for the time of year.

Comparing the record volume for the first four months of 1955 with that for the first four months of 1954, private expenditures (at $8.6 billion) were 21 percent higher, but public outlays (at $3 billion) were 3 percent lower. Increased spending by state and local governments was not great enough to offset decreased federal spending.

The greatest dollar gain over 1954, when the first four months are compared, was in private residential building. The $4.6 billion of new residential building put in place during the January-April period represents a seasonally adjusted annual rate of $16 billion, as against $12 billion for the first four months of 1954, when the current housing boom had not yet started. By the final quarter of 1954 the annual rate had not quite reached $15 billion, and actual expenditures during the entire year totaled about $13^1/_2$ billion.

Most of the major construction categories showed an advance this year over last, when the January-April period is compared. The exceptions were farm and railroad construction, public industrial building, public housing, and conservation and development work.



April construction outlays, rising to a new high for the month of $3.2 billion, account for a record total of $11.6 billion for the first four months of the year.

Alaska Engineer District Completes Fuel Pipeline

The 625-mile-long pipeline portion of the $40,000,000 military fuel line project between Haines and Fairbanks, Alaska, has been completed, and completion of the pumping stations early this fall is expected, according to an announcement from the Alaska District of the Corps of Engineers. Despite the problems involved in crossing hundreds of miles of muskeg, tundra, and mountainous terrain, the pipeline was laid in one season, with the exception of a 1,000-ft final gap over the Slim River in Yukon Territory, which had to wait for the recent winter freeze-up to provide safe passage for men and heavy equipment.

Under supervision of the Alaska District of the Corps of Engineers, the pipeline is being constructed by a combine consisting of Williams Brothers Co., of Tulsa, Okla., the Marwell Construction Co., Ltd., of Vancouver, B.C., and the McLaughlin Construction Co., of Great Falls, Mont.

Egypt to Build New Dam on Nile

The Egyptian government has obtained the promise of a $280,000,000 loan from the National Bank of Egypt to buy foreign equipment and machinery and steel supplies for use in constructing a high dam on the Nile. Total cost of the dam is estimated at $520,000,000. Although present plans call for beginning the dam next April, construction may be delayed by the failure of Egypt and the Sudan to agree on the partition of Nile River waters. Such an agreement will be required before either country can begin a new river project.

Air Force Acquires Mammoth Aluminum Forging Presses

These two giant presses will provide vital production facilities for aircraft structural components at the U. S. Air Force's new Heavy Press Plant at the Cleveland works of the Aluminum Company of America. Installation of the enormous hydraulic forging presses marks the half way point in the Air Force's Heavy Press Program, which will enable manufacturers to produce the very thin wings and strong structural members needed for aircraft. At dedication ceremonies on May 5, when the 50,000- and 35,000-ton presses began operation, Air Force Secretary Talbott hailed the $40,000,000 forging plant as a "force for peace." The plant will be operated by Alcoa on a lease arrangement.

N.Y. Coliseum Floor Collapses During Construction

Tragedy struck May 9 when 10,000 sq ft of freshly poured concrete for the exhibition floor of New York's new Coliseum collapsed. The accident, involving some 21,000 sq ft of floor and 500 cu yd of concrete, caused the death of one man who was trapped beneath the collapsing concrete which funneled through to the floor below. It is estimated that construction will be delayed six weeks and the resulting cost of the disaster will be around $150,000.

Hearings are being held before a grand jury, but as this issue goes to press no report has been made public as to the cause of the failure.

The shoring that collapsed was double tiered. The lower tier consisted of 10-ft 4 x 4 timber shores capped with 4 x 4 headers which supported adjustable pipe shores about 10 ft long. The lower timber shores were braced horizontally in two directions and the pipe shores, placed on 2-ft 6-in. centers, were partially braced.

On the day of the collapse, over 550 cu yd of concrete were being poured. Placement was by 12-cu ft power buggies. There were approximately 1,000 men on the project at the time of the accident.

New Philadelphia Treatment Works Begins Operation

Philadelphia's new $8,000,000 Southwest Sewage Treatment Works, which recently went into operation, is designed to serve a population of 1,200,000 (estimated for the Southwest Disposal District by 1970) and to treat an average daily flow of 136 mgd. It is the second of three plants to be put in operation since the inauguration of a multi-million-dollar program for the sanitary cleanup of the city and its environs. The Southwest Works will serve a 56.3-sq mile area, including all the city west of the Schuylkill River. When its network of intercepting sewers and other appurtenant facilities is completed, the project will end the city's discharge of raw sludge into the Schuylkill. Construction of the Southwest Works started in 1949.

The city's $80,000,000 Northeast Works, an expanded and modernized development of an earlier treatment project, was put in operation in April 1951 as the first unit in the new program. The third and final unit, the Southeast Works, is scheduled to begin operation late this year.

$200 Billion Public Works Program Forecast

The U.S. Department of Commerce, after studying reports of various agencies and private groups, reports that nonfederal public works expenditures must be increased to $20 billion dollars per year for the next ten years. This more than doubles the 1954 record volume of $8.5 billion. The magnitude of such a volume of construction may be better comprehended when it is noted that, compared to 1954 prices, the 1955–1964 program is nearly four times the volume of the previous ten years and one-third more than the total volume of this type of work for the past 35 years.

The Department of Commerce in making these figures known in its publication, *Construction Review*, further states that: "The public works backlog provides a strong stabilizing force for the economy in the next decade, and it must be substantially erased by 1956, if severe community problems are to be avoided. The marriage boom in 1965–1975, reflecting the baby boom in 37 million births in 1945–1954, implies an even greater demand for housing and for new community facilities than at present. Long-run stability dictates that extensive efforts should be made to overcome these deficits during the next ten years when new family formation will continue at comparatively moderate rates."

The breakdown of non-federal figures given shows the greatest increase over 1954 figures among hospital and institutional buildings. The average annual figures in the report are: Highways $9.2 billion, educational buildings $4.2 billion, hospital and institutional buildings $2.2 billion, water and sewage works $2.5 billion, and $2.3 billion for other non-federal public works.

Susquehanna River Reservoirs Planned

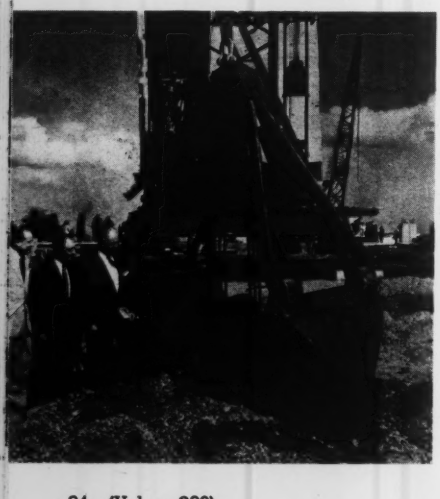
Plans for constructing three flood-control reservoirs in the basin of the West Branch of the Susquehanna River are announced by the Baltimore District of the Corps of Engineers. The three projects were authorized by the Flood Control Act of 1954. A fourth project, which was initiated by the Baltimore District during the course of engineering studies and recommended as a unit in the system, is being built by the General State Authority of the Commonwealth of Pennsylvania.

The authorized projects are Curwensville Reservoir, which will be located on the West Branch near Curwensville and will control a drainage area of 369 sq miles; Kettle Creek Reservoir, which will be on Kettle Creek above its confluence with the West Branch and drain a 229-sq mile area; and Blanchard Reservoir, which will be on Bald Eagle Creek, a tributary of the West Branch, and drain a 352-sq mile area. Present estimated costs are $24,500,000, $15,700,000, and $23,300,000. Plans call for concrete gravity dams for the Curwensville and Kettle Creek projects and an earthfill structure for Blanchard Reservoir.

The reservoir under construction by the state of Pennsylvania is located on First Fork of Sinnemahoning Creek. It will control a drainage area of 243 sq miles. The dam is an earthfill structure.

Stephen E. Smith is district engineer of the Baltimore District, and John T. Starr, M. ASCE, is chief of the Planning and Reports Branch of the District.

Ground Broken for New Mississippi River Bridge



While officials watch, a crane breaks ground for the new $65,000,000 Mississippi River Bridge, which will connect the center of New Orleans with the west bank. Shown, left to right, are deLesseps S. Morrison, mayor of New Orleans; Neville Levy, chairman of the Mississippi River Bridge Authority; and George S. Covert, director of the Louisiana State Highway Department. A cantilever structure, the bridge will have a 1,575-ft center span—longest in the United States and third longest in the world. The Dravo Corporation, of Pittsburgh, is handling the first phase of the work consisting of construction of four huge piers. The largest of the piers will be as high as a 34-story building and more than half under water. Modjeski & Masters are the consulting engineers.

Stainless Steel, Reversible Windows Developed for Socony-Vacuum Building

Production of a unique new hurricane-resistant, reversible, stainless steel window has begun for installation in the 42-story Socony-Vacuum Building now under construction in New York. The window was designed by Truscon Steel Division engineers for the firm of Harrison & Abramovitz, architects. Installation of 3,200 of the windows in the huge office building will be completed this summer.

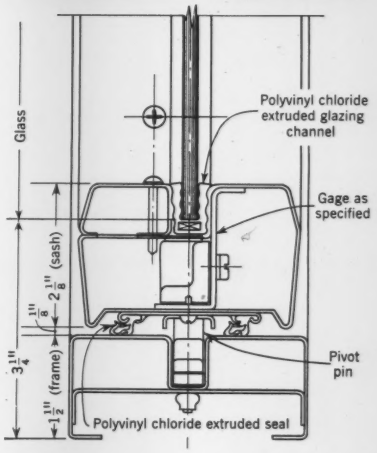
Both the frame and vent of the fully reversible window are of 20-gage Republic "Enduro," Type 302 (AISI) stainless steel. The vent is glazed with $^1/_4$-in. plate glass set in a glazing channel of extruded polyvinyl chloride. The glass is securely locked in the vent frame by means of a box-section glazing strip fastened with Phillips-type machine screws. The mitered corners of the frame are arc welded at the seams, while the vent corners are reinforced by concealed nickel-bronze castings.

The window rotates a full 360 deg on pivots which bear on stainless steel pivot blocks concealed in the frame. The vents are easily removed for glazing by unbolting half of each spilt pivot block at top and bottom of the frame.

Positive air and watertight seal is provided by a double gasketing of polyvinyl chloride with a combination tube and squeegee weathering section. Gaskets are precisely fitted between the stainless steel vent and frame, completely surrounding the window opening. If severe weather should force any moisture through the outer squeegee strip, water and air pressure will be relieved by the drain channel in the frame sill.

At the University of Miami's Housing Research Bureau, the new window was subjected to the spectacular and tough Hurricane Test, in which a continuous, 100-mph blast of wind and water was hurled directly at the window from close range by a 1,200-hp aircraft engine. Even at hurricane gust velocities of up to 145 mph, and a 30-gpm deluge of water equal to a 4-in. rainfall, not a drop of moisture penetrated. Air infiltration was also negligible.

New York City window cleaning contractors estimate that the window's free-swinging feature, which permits safe, fast cleaning from the inside, will cut annual cleaning costs per window from $9 for conventional double-hung sash to $4.50. In addition, it is estimated that the window's tight seal, which prevents leakage of either heated or cooled air from the building, will provide annual savings of $3.54 per window over conventional-type frame and sash.



Closeup of free-swinging, stainless steel window, which is being made for the Socony-Vacuum Building, by the Truscon Steel Division of Republic Steel Corp., is given in the photo. A section through sill and pivot is shown in the sketch.

NUCLEAR NOTES

XI—Techniques of Radiation Measurement (Part 2)

This installment completes the study of techniques of radiation measurement (May issue), which was prepared by Morton I. Goldman, J.M. ASCE, at the request of the Sanitary Engineering Division's Committee on Sanitary Engineering Aspects of Nuclear Energy. Conrad P. Straub, of the Oak Ridge National Laboratory, Oak Ridge, Tenn., heads the committee, which also includes Earnest F. Gloyna, A. E. Gorman, Prof. Warren J. Kaufman, Alexander Rihm, Jr., and James G. Terrill, Jr.

Next month's subject will be: Statistics of Nuclear Measurements.

Two absorption effects are important when counting alpha or beta radiations. The first, self absorption, takes place in the mass of the source itself and is most significant for alpha and for weak beta radiations, although samples of appreciable thickness may introduce serious losses with higher energy beta radiations. Self-absorption of gamma radiation is negligible in most cases of radiation measurement. The other significant absorption effect is due to media between the source and the sensitive volume of the detector. Again the effect is most significant in the case of alpha and beta radiation, although some scintillation phosphors are insensitive to low-energy photons because of aluminum jackets enclosing the phosphor.

The ratio of the measured activity of a given sample to the known disintegration rate of the sample is the counting efficiency. This is quite frequently referred to as the "geometry" of the counter for that sample arrangement, because frequently the geometry introduces the major portion of the overall correction factor. To determine the absolute disintegration rate of a sample it is necessary to know the counting efficiency for the particular sample arrangement which may be done by calculating each of the several correction factors involved, or by counting a similar sample of known disintegration rate and applying the efficiency factor thus obtained.

Counting "standards" of many isotopes are available from the National Bureau of Standards, and from several commercial suppliers. In applying the efficiencies determined from these standards, the conditions of their measurement must closely match those under which the sample is measured and the counting rates of the two must be approximately the same. The standard should be

mounted on the same type pan, and have approximately the same energy spectrum as the sample. The counting itself must be done under similar conditions of geometry. In many cases these requirements for a counting standard cannot be met, most frequently because of mismatched energies, hence, the correction of sample counting rates to absolute disintegration rates is subject to some error, the size of the error depending upon the magnitude of the energy discrepancy. Whenever results are reported in absolute units and the standard is not the same as the sample, it is desirable to indicate the standard upon which the efficiency factor is based. Comparative counting, it may be recalled, requires only that control and processed samples be measured under conditions of unspecified but equal counting efficiency.

Two other factors which usually must be applied to sample counting rates, regardless of whether the measurement is absolute or comparative, are corrections for background radiation and (in the case of G-M counters) for resolving time losses or coincidence. Background radiation originates elsewhere than in the sample—most frequently from cosmic sources and from naturally occurring radioactive materials, and occasionally from strong sources in the vicinity of the counter. This rate is always measured immediately before or after the sample, and must be subtracted from the gross rate to determine the net sample contributed. To decrease this background contribution and to minimize variations in background from nearby sources, most laboratory detector elements are housed in a shielding structure of lead commonly called a "pig." Background counting rates vary widely among instrument types, depending on the horizontal projected area of the counting element and, for most instruments in common use, range from 20 to 100 counts/minute for shielded G-M counters to 500 to 1,000 counts/minute for scintillation counters.

In the operation of a G-M counter, each ionizing event detected produces a discharge which renders the tube insensitive to further radiations for a period known as the dead time; this period may last for several hundred micro-seconds. Assuming that it takes 200 micro-seconds for the tube to recover, the maximum evenly spaced counting rate should be $\frac{1}{2 \times 10^{-4}} = 5{,}000$ events/second. An average counting rate which would space events by times greater than the dead time would still exhibit some losses due to the fact that the decay process is *random* and two successive events may well occur in a time interval less than the average time. For a given counter these losses become increasingly important as the counting rate increases and as the dead time increases for a given counting rate. The true counting rate (N) of a sample can be calculated from the observed rate (n) if the dead time in consistent time units is known by means of expression:

$$N = \frac{n}{1 - nt}$$

The random nature of the decay process is of extreme importance in evaluating results obtained from radiation measurements. The application of statistics to the random phenomenon of radioactivity will be presented in the next issue of Nuclear Notes.

References

1. *Nuclear Radiation Physics* (Chapter II), R. E. Lapp and H. L. Andrews. Prentice-Hall, Inc., New York (1948).
2. *The Measurement of Radioisotopes* (Chapter VI), D. Taylor. J. Wiley and Sons, Inc., New York (1951).

Concrete Pipe Engineers Hold Annual Convention

Board of Directors of the American Concrete Pipe Association is photographed during the organization's recent 47th annual meeting in Boston. Seated, left to right, are Treasurer J. D. Mollendorf, president, Continental Concrete Pipe Corp., Chicago; Secretary David A. Decker, M. ASCE, Mid-West Concrete Pipe Co., Franklin Park, Ill.; Vice-President E. F. Bespalow, M. ASCE, vice-president, Choctaw, Inc., Memphis, Tenn.; President A. W. G. Clark, president, B. C. Concrete Co., Ltd., Vancouver, B.C.; and Vice-Presidents Harry W. Heath, Lock Joint Pipe Co., East Orange, N.J., and Hugh P. Ford, Eugene Concrete Pipe & Prod. Co., Eugene, Oreg. Standing, in the same order, are Howard F. Peckworth, M. ASCE, managing director, Chicago; Director Richard I. Young, vice-president, United Concrete Pipe Corp., Baldwin Park, Calif.; C. M. Adams, proxy for Director Peter Van Kuran, American Pipe and Construction Co., South Gate, Calif.; Director Ivy H. Smith, president, Sherman Concrete Pipe Co., Jacksonville, Fla.; Director Henry C. Eames, president, New England Concrete Pipe Corp., Newton Upper Falls, Mass.; Director George B. Denham, vice-president, Faulkner Concrete Pipe Co., Hattiesburg, Miss.; Director R. A. Norman, vice-president, the Cretex Co., Inc., Elk River, Minn.; Director Henry O. Strohecker, Jr., president, Carolina Concrete Pipe Co., Charlotte, N.C.; and Director R. B. Carroll, president, Sherman Concrete Pipe Co., Inc., Birmingham, Ala. Some 250 representatives of the concrete pipe industry attended the three-day meeting, which produced a number of interesting papers on improved methods of using the product.

Two Engineering and Building Firms Merge

Two well known engineering and building organizations—the Thompson-Starrett Company, Inc., founded in 1899, and the Roberts & Schaefer Company, founded in 1904—recently merged, retaining the name of the parent firm, the Thompson-Starrett Company, Inc. The company has its principal office at 130 North Wells Street, Chicago 6, and its Eastern branch office at 254 West 54th Street, New York 19. John E. Kalinka, of the former Roberts & Schaefer Company, is president, and George J. Meyers, of the former Thompson-Starrett Company, remains vice-president in charge of foreign operations. Robert Zaborowski, M. ASCE, is in the Chicago office as special assistant to the president, and Warren R. Hedden and Anton Tedesko, M. ASCE, are heading the New York office.

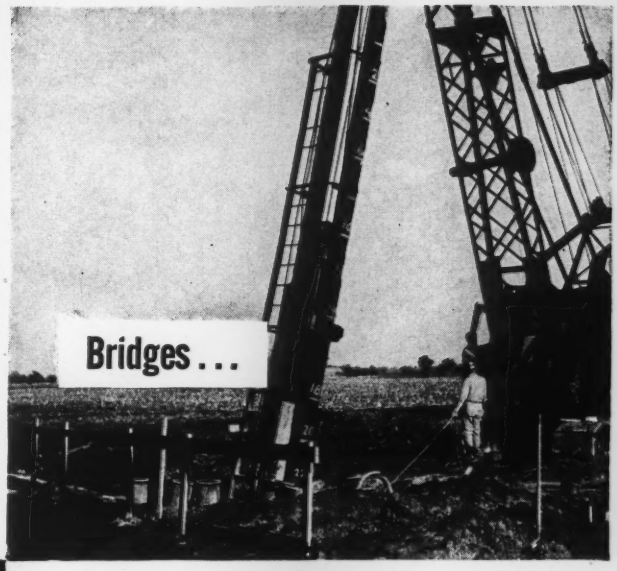
The company will continue to provide the design and construction services previously provided independently by the two separate companies.

Armco pipe piles

Drive Straight...

and you can

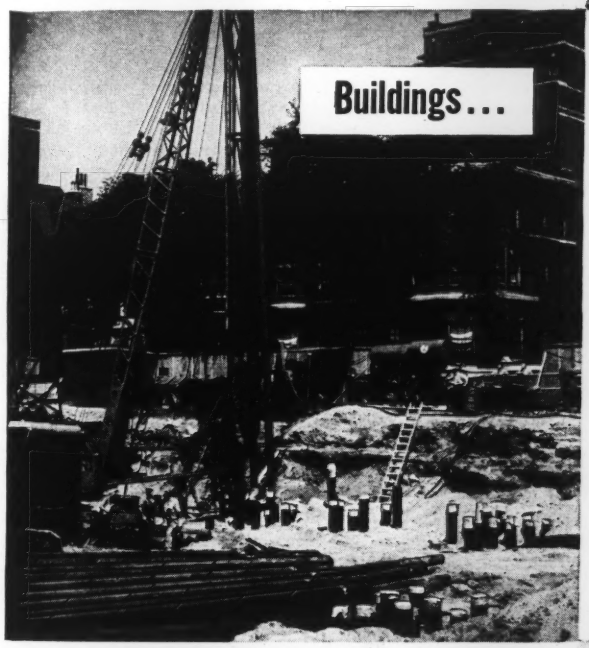
prove it



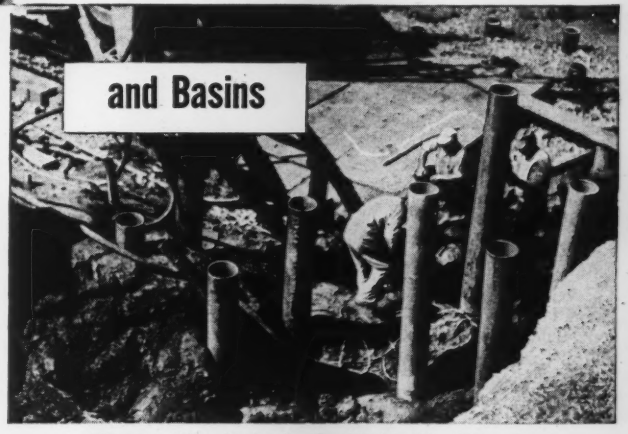
Armco Piling being driven for the foundation of a grade separation structure on the Indiana Toll Road.

The continuous spiral seam method of manufacturing makes Armco Steel Pipe Piling straight and round—and high collapse resistance keeps it that way. What is more, you can check the driven pile for alignment and watertightness. Inspection is simple with either a light or mirror.

Armco Pipe Piles are available in a wide range of diameters and wall thicknesses. Pile lengths are limited only by handling and shipping facilities. Write us for complete data. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 5555 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco International Corporation.



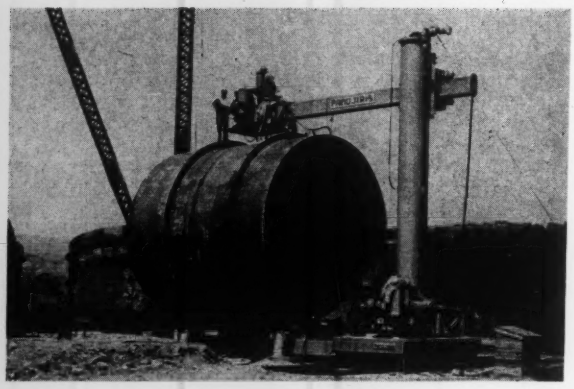
Long length of Armco Piling is in the leads, ready to be driven for apartment building foundation on Lake Shore Drive, Chicago.



Primary settling basins for the Steubenville, Ohio, sewage treatment plant will rest on Armco Piling.

ARMCO®

Armco Steel Pipe Piling



Welding Unit Speeds Littleton Dam Work

An open field at the Littleton Dam job site, Littleton, N.H., becomes an efficient welding shop through use of the Pandjiris Weldment Company's RBM type welding head manipulators. The job called for automatic submerged-arc welding of approximately 3,500 ft of girth seams on penstock joints ranging from $16\frac{1}{2}$ to $19\frac{1}{2}$ ft in dia, with steel plate thickness ranging from $\frac{5}{8}$ to $\frac{15}{16}$ in. Welding speed averaged 20 in. per min. The RBM manipulator is a self-contained unit consisting of a variable speed pedestal car, rotating trunnion, column, saddle and variable-speed-drive welding boom with end-mounted automatic welding head. It is remote controlled.

New York Port Authority Elects New Chairman

Donald V. Lowe, of Tenafly, N.J., has been elected chairman of the Port of New York Authority, succeeding Howard S. Cullman, who has resigned after ten years as chairman and twenty-eight years as commissioner. Mr. Lowe has been vice-chairman of the Authority for the past two years and a commissioner for ten years. Mr. Cullman has been elevated to the newly created post of honorary chairman.

N. G. Neare's * COLUMN

R. ROBINSON ROWE, M. ASCE

"Well, Joe Kerr," bragged Joe Kerr," has done it again. My uncle, Hi Kerr, is an infantry colonel, and he told me that 4 men could be a squad, which was probably the gimmick in your battalion problem."

"A squad might be only 4 men," admitted Professor Neare.

"But I heard ...," sputtered Cal Klater.

"Wait, Cal; Joe has the floor."

"Thanks, Professor," said Joe. "Here's my answer. There were 432 men on Tuesday, organized in 108 4-man squads. Losing a man per squad, there were only 324 reported Wednesday morning, moving the left digit to the right end. These were reorganized into 81 4-man squads, so that the second ambush costing a man per squad left only 243 to report Thursday morning and for the second time the left digit was moved to the right end. Finally the major reorganized into 27 9-man squads. What could be sweeter?"

"Before I concede that," said the Professor, "let's hear what Cal heard."

"I heard that a command of 4 to 11 men could be a squad and that larger commands were divided into squads of 6 to 9 men, with 8 men in a 'full squad.' The problem implied 8 when the 9th was added for a possible third ambush. Then if we let a and b be the transient digits and x the remaining n digits, we have:

$$7(x + 10^n b + 10^{n+1} a) = 8(a + 10x + 10^{n+1} b) \quad \ldots\ldots (1)$$

$$7(a + 10x + 10^{n+1} b) = 8(b + 10a + 100x) \quad \ldots\ldots (2)$$

which can be reduced to

$$\frac{7 \cdot 10^{n+1} - 8}{73} = \frac{10^n + x}{a} = \frac{10x + a}{b} = q \quad \ldots\ldots (3)$$

for which the quotient q must be a whole number. This is easily found by dividing 69999..92 by 73, bringing down the 2 instead of a 9 whenever it will make the remainder divisible exactly by 73. Finding $q = 958904$ with $n = 6$ and substituting back in (3), I eliminated x to find

$$9589041a = 10958904b \quad \ldots\ldots (4)$$

which reduces to $7a = 8b$. To be digits less than 10, we must make $a = 8$, $b = 7$, whence $x = 671232$. The battalion started with 87671232 men and ended with 67123287 reorganized into 7458143 9-man squads."

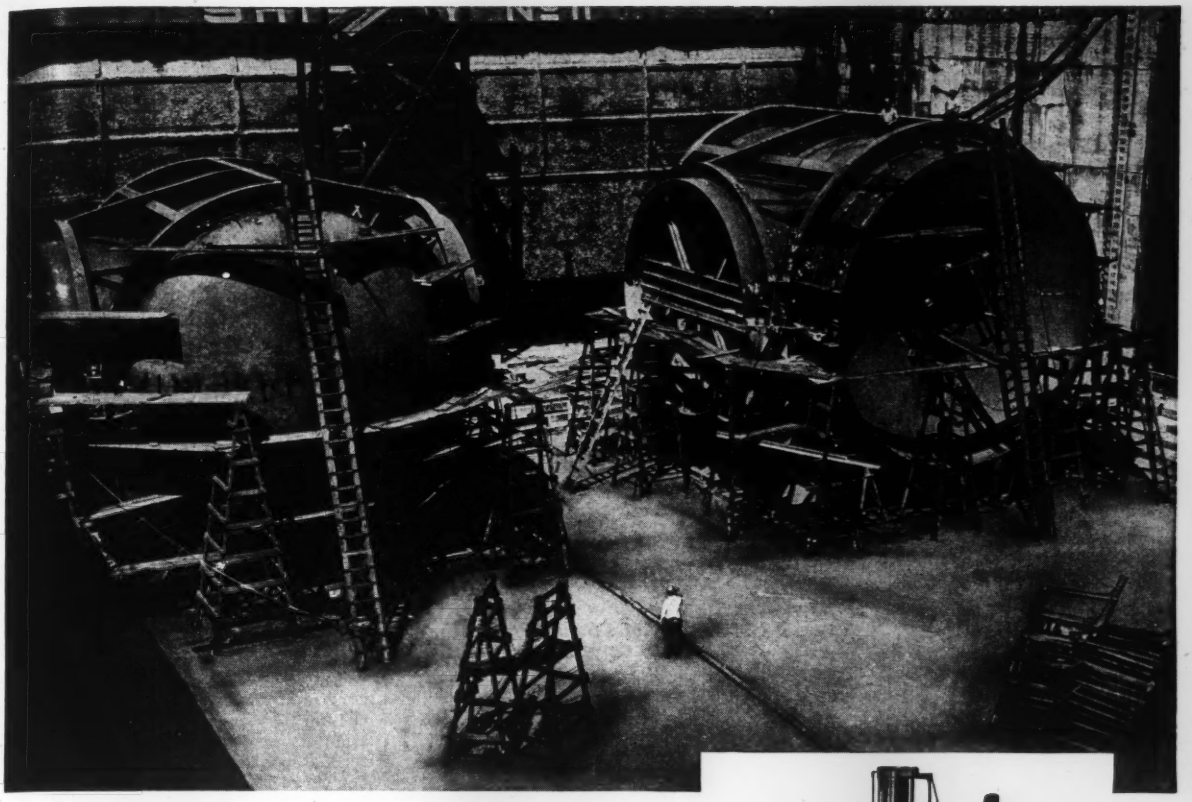
"That's it," exclaimed the Professor. "Joe's answer earns part credit for its reasonable battalion, but yours fits the squad and conforms to Comte de Bussy's claim that 'Dieu est toujours pour les gros bataillons.' Now for smaller numbers and lighter motif, listen to Guest Professor Eichenspufem. Go ahead, Ike, and spoof 'em."

"I'll try," said Ike, "with the story of Bobby Bock's blocks that always seemed to take an hour to put away at bedtime. One night, seeing all 36 of them piled in 11 stepped columns (Fig. 1), Papa Bock proposed a game to Bobby. 'Let's each in turn take all or part of any column and

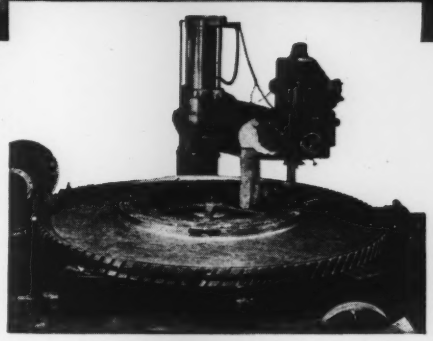
Fig. 1. The game of blocks-to-box and loser-to-bed

pack them in the block box. I'll start and whoever plays last goes right straight to bed.' Bobby jumped at the chance of sending Daddy sleepy-bye, but who won and why?"

[*Kerrs and Klaters indiscriminately were: S. K. Rueball (Keith Jones), Ed C. Holt, Jr., Thatchrite (Guy C. Thatcher), Sauer Doe (Marvin Larson), R. E. Philleo, Judson Ferentz, and Murray S. Bornstein (who also sent a late but correct measure of Marilyn). Holt is also Guest Professor Eichenspufem.*]



ASSEMBLING FLOW DIVERSION VALVES of an 8-foot supersonic wind tunnel for the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics.



DRILLING A 25-TON FORGING . . . one of 11 alloy steel discs used in one of the two axial flow compressors which Newport News is constructing for the NACA's Ames laboratory.

Man-made Hurricanes

PUSH A BUTTON . . . That's all it will take to accelerate wind up to several times the speed of sound in a new supersonic wind tunnel at the Ames laboratory of the National Advisory Committee for Aeronautics, in Moffett Field, California.

The tunnel is designed to develop new aerodynamic information. Its heart is the "windmaker" . . . two axial-flow compressors which look like a giant tube 50 feet long and 24 feet in diameter, studded with small blades.

Because of the size of this unit, it is significant that the task of building these mammoth compressors was assigned to Newport News.

Newport News has also constructed two diversion valves, similar to huge plug valves, for diverting the air flow from one channel of the tunnel to another, as desired.

Large engineering and technical staffs, operating a plant with acres of brass, iron and steel foundries, five huge machine shops and other extensive fabricating facilities, make Newport News an ideal source for large equipment . . . *standard or special in design.*

Products ranging from components of rayon spinning machines to giant 165,000 horsepower hydraulic turbines operating at Grand Coulee, reflect Newport News' high integration of skill and production facilities.

Consult us on equipment for your present or future projects. Write today for your copy of *"Facilities and Products."*

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY
Newport News, Virginia

DECEASED

Harold Norman Abelson (A.M. '45), age 47, assistant resident engineer for the Seattle District of the Corps of Engineers on Albeni Falls Dam, at Newport, Wash., died March 26. Mr. Abelson worked on Coulee Dam from 1935 until 1942 when he became assistant construction engineer for the Tacoma Second Nisqually Power Development, Lagrande Dam and tunnel. He had also been resident engineer for Tacoma City Light on its Cowlitz Dam Project. He graduated from Washington State College in 1934.

George Barclay Bassett (M. '93), age 93, chairman of the Board of the Buffalo (N.Y.) Meter Co., which he founded in 1892, died in that city on April 14. Mr. Bassett was president and general manager of the company from 1892 until his retirement in 1945. For seven years prior to 1892, he was associated with his brother in a construction firm that built more than sixty waterworks in western New York. He had been president of the Buffalo Engineering Society.

Donald R. Cubbage (M. '49), age 46, chief airport engineer for the Military Air Transport Base, Great Falls, Mont., died in a recent plane crash near Salt Lake City. Following graduation from the Montana State School of Mines in 1934, Mr. Cubbage was with the U.S. War Engineers in Montana, Alabama and Florida. The following six years he was with the Bureau of Reclamation in Montana.

Orin Levis Davis (M. '31), age 64, since 1922 manager and chief engineer of the Ceco Steel Products Corporation, Kansas City, Mo., died December 27. A 1911 graduate of Iowa State College, Mr. Davis had been associated with Ceco Steel since 1918. Previously he had worked for the C.B. & Q. Railroad in Nebraska and Colorado and been assistant manager of the Concrete Engineering Co. in Omaha.

Frederick William Dencer (M. '09), age 78, who was with the American Bridge Co., from 1901 until his retirement in 1941, died in Chicago on February 18. From 1911 to 1929 Mr. Dencer was engineer at the Gary, Ind., plant, and after that was assistant division engineer for the company in Chicago. He received B.S. and C.E. degrees from Purdue University.

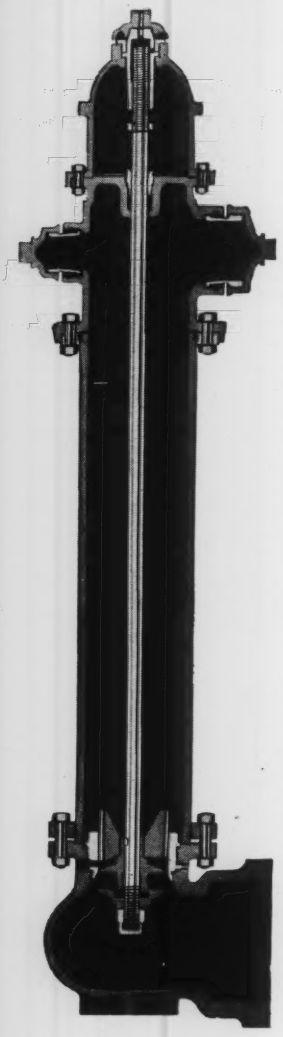
Walter Maxwell Fife (A.M. '25), age 64, for 33 years a member of the civil and sanitary engineering department at Massachusetts Institute of Technology, died on April 22. A graduate of the University of Alberta, Professor Fife was an instructor and then assistant professor there from 1913 to 1922. At M.I.T., he became associate professor in 1928 and associate professor of structural engineering in 1941.

Theodore L. Condron Former Director, Dies

Theodore L. Condron (M. '01), retired Chicago consultant and Director of the Society from 1923 to 1925, died at Oak Park, Ill., on April 12. He was 88. From 1901 until his retirement in 1947, Mr. Condron was in private practice in Chicago—for many years in partnership with Chester L. Post. His clients included such firms as the Ford Motor Co., General Motors, and General Electric. He was an honorary member of the Western Society of Engineers and of the Chicago Engineers Club, which he helped found in 1903. Recent honors included the Distinguished Service Certificate of the National Council of State Boards of Engineering Examiners for his work as one of the authors of the original engineering registration laws.

T. L. Condron

(*Continued on page 94*)



To meet every requirement you can depend on the MATHEWS Flange Barrel Hydrant

For maximum reliability at lowest cost, you can't buy better than the Mathews Flange Barrel Hydrant. It has all the features that you look for in a top-quality hydrant — internal parts removable through the barrel, compression-type valve to prevent leaking in case of damage, completely revolving head. In addition, every friction point is protected by at least one bronze surface, and all water-carrying areas are designed to reduce friction and loss of pressure.

And at slight extra cost...

The Breakable Flange and Stem Coupling—A specially designed flange in the standpipe just above ground level and a frangible coupling in the hydrant stem are both designed to snap when struck a blow heavy enough to break the hydrant. Both can be replaced quickly and inexpensively without excavation, while the rest of the hydrant remains undamaged.

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Made by R. D. Wood Company
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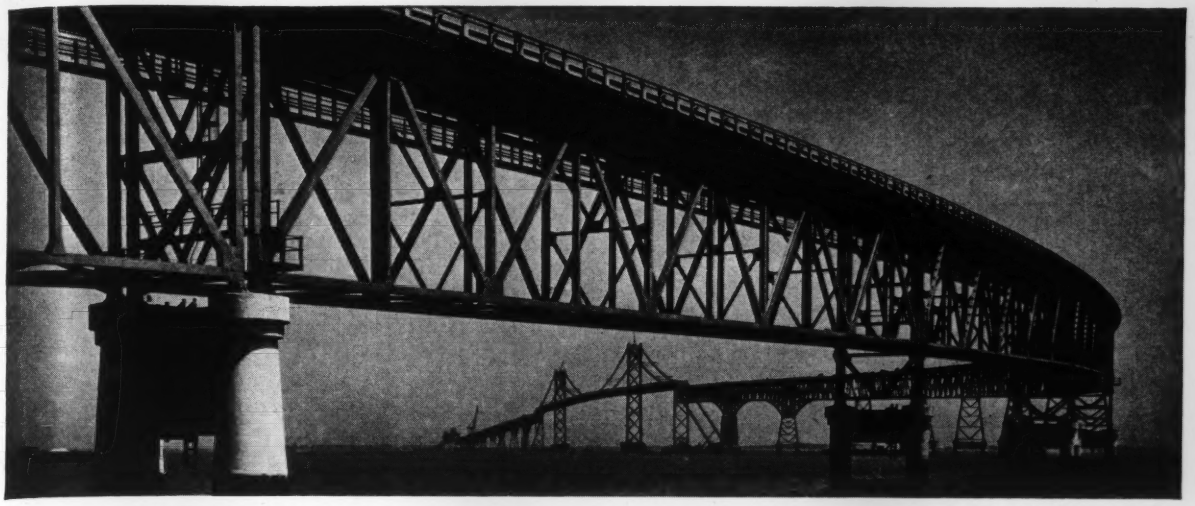
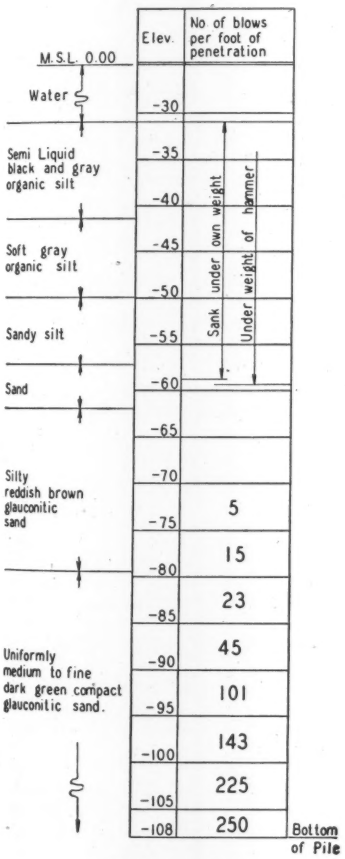
Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

- Send for this 80-page catalog. It contains full information about the R. D. Wood line of Cast Iron Pipe, Fire Hydrants, Gate Valves, and Hydraulic Machinery.



J. E. Greiner Company, of Baltimore, designed and supervised construction of the Chesapeake Bay Bridge for the Maryland State Roads Commission.

Steel H-Piles Prove Sound as Friction Piles for Chesapeake Bay Bridge



DRIVING RECORD
BP 14 x 102#
HAMMER - VULCAN NO. 0
E = 24,375 FT LBS

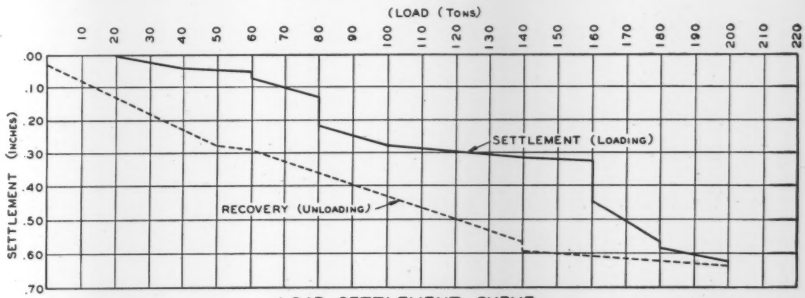
The sub-structure of the 4-mile-long Chesapeake Bay Bridge connecting Maryland's Eastern Shore with the mainland consists of 124 concrete piers supported on piles. Some of these piers are in water up to 90 ft deep.

All of the deep piers rest on steel H-piles used as friction piles. They were driven underwater through platform templates secured to the bay bottom. Elevation of pile cut-off was near bay bottom. The concrete was placed in huge permanent steel forms lowered to the submerged platforms.

At the bridge site bedrock lies so far below the surface that it could not be used for foundations. However, within the practical limits for H-piles is a stratum of medium to fine compact sand. A comprehensive program of loaded test piles proved that, when driven into this stratum, H-piles developed very high resistance.

Shown below is the load settlement curve for one of the test piles, driven 35 ft into the compact sand. With a test load of 200 tons the net settlement after rebound was only 0.024 in.

Based upon the information from this and numerous other test piles, the engineers, J. E. Greiner Company, of Baltimore, designed the foundations of the Chesapeake Bay Bridge using H-piling. Bethlehem furnished approximately 15,000 tons of steel H-piles for the bridge's sub-structure.



LOAD SETTLEMENT CURVE

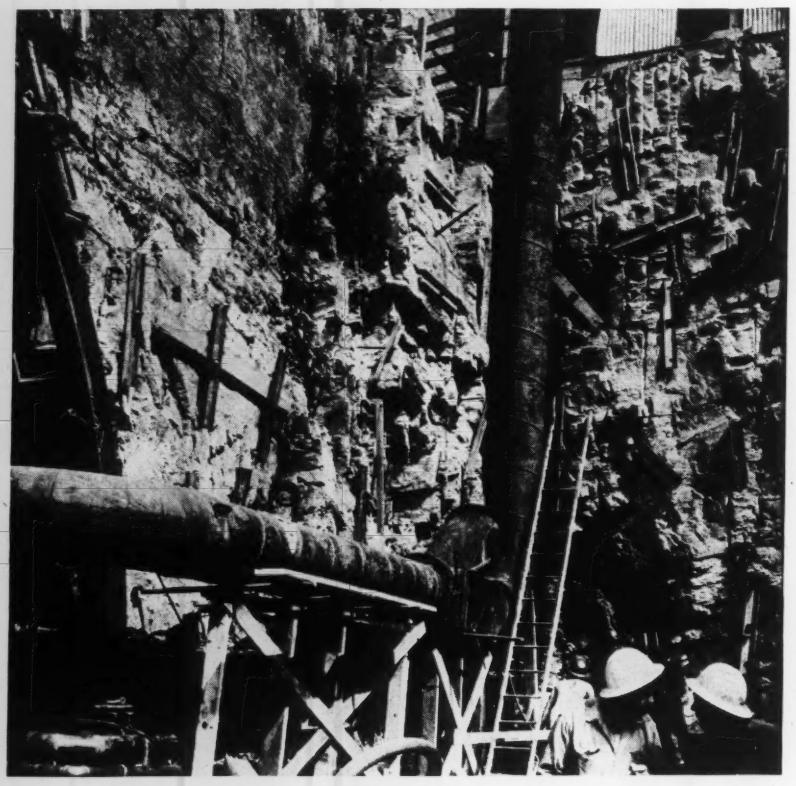
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

AIR FUNNEL FOR TUNNEL



For those vital ventilating lines in underground construction, contractors know they can depend on Naylor Spiralweld pipe. Along with light weight for easier handling and installation, Naylor pipe offers a structure with the collapse strength necessary for push-pull ventilation. With Naylor one-piece Wedge-Lock couplings to speed connections, you have a combination that's made to order for construction jobs like this. Sizes: 4″ to 30″ in diameter. Thickness from 14 to 7 gauge.

Write for Bulletin No. 507.

NAYLOR PIPE

NAYLOR PIPE COMPANY

1281 East 92nd Street, Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 350 Madison Avenue, New York 17, New York

Deceased

(*Continued from page 92*)

John Martin French (J.M. '43), age 33, since 1950 structural engineer for Gibbs & Hill, Inc., Los Angeles, Calif., died at his home in Sierra Madre on March 26. After receiving his master's degree from California Institute of Technology in 1944, Mr. French became associated with a Naval Ordnance Project there. Later he was civil design engineer for the U.S. Naval Ordnance Test Station at Pasadena.

Frederic Francis Hall (M. '38), age 78, San Francisco structural engineer and a resident of Berkeley, died in Oakland on March 26. Mr. Hall had been in practice in San Francisco since 1908—since 1937 as a member of the firm, Hall, Pregnoff, & Matheu and its predecessor, Hall & Pregnoff. He designed some of San Francisco's most important structures, including the City Hall and the Pacific Gas & Electric Building. He was a graduate of Cornell University and had done graduate work at the University of California.

John Frederick Johannsen (M. '29), age 69, with the Hyster Company, Portland, Oreg., since 1944, most recently as company consulting engineer, died on March 30. At the start of his career Mr. Johannsen worked for various companies in Los Angeles, the U.S. Army at the Rock Island (Ill.) Arsenal, and the Dodge Brothers Motor Co. ordnance plant at Detroit. From 1921 to 1929 he worked for the City of Glendale, Calif., holding various positions and from 1929 to 1944 he was with R. G. LeTourneau, Inc., in Peoria.

Raymond Earl Kerr (A.M. '17), age 71, died at his home in Washington, D.C., on April 2. Mr. Kerr for many years was receiver and general manager of the Morgantown & Wheeling Railway, Morgantown, W. Va. In 1937 he went to Washington with the Bituminous Coal Commission which he served until the war. He then became director of the Division of Fuel and Utilities, Office of Civilian Requirements. He retired in 1947.

Ragnar John Mattson (M. '48), age 60, since 1950 associated with the Paul Anderson Construction Co., Vasteras, Sweden, died on February 28. A graduate of the Royal College of Engineering in Sweden, class of 1920, Mr. Mattson was design engineer for the Foundation Co. of New York and Montreal from 1925 to 1940. He then became hydraulic engineer for the Aluminum Co. of Canada, and from 1946 to 1950 was engineer-in-charge of planning and design for the Damodar Valley Corp. in Calcutta.

Francis John Mulvihill (A.M. '25), age 67, landscape design architect for the

(*Continued on page 96*)

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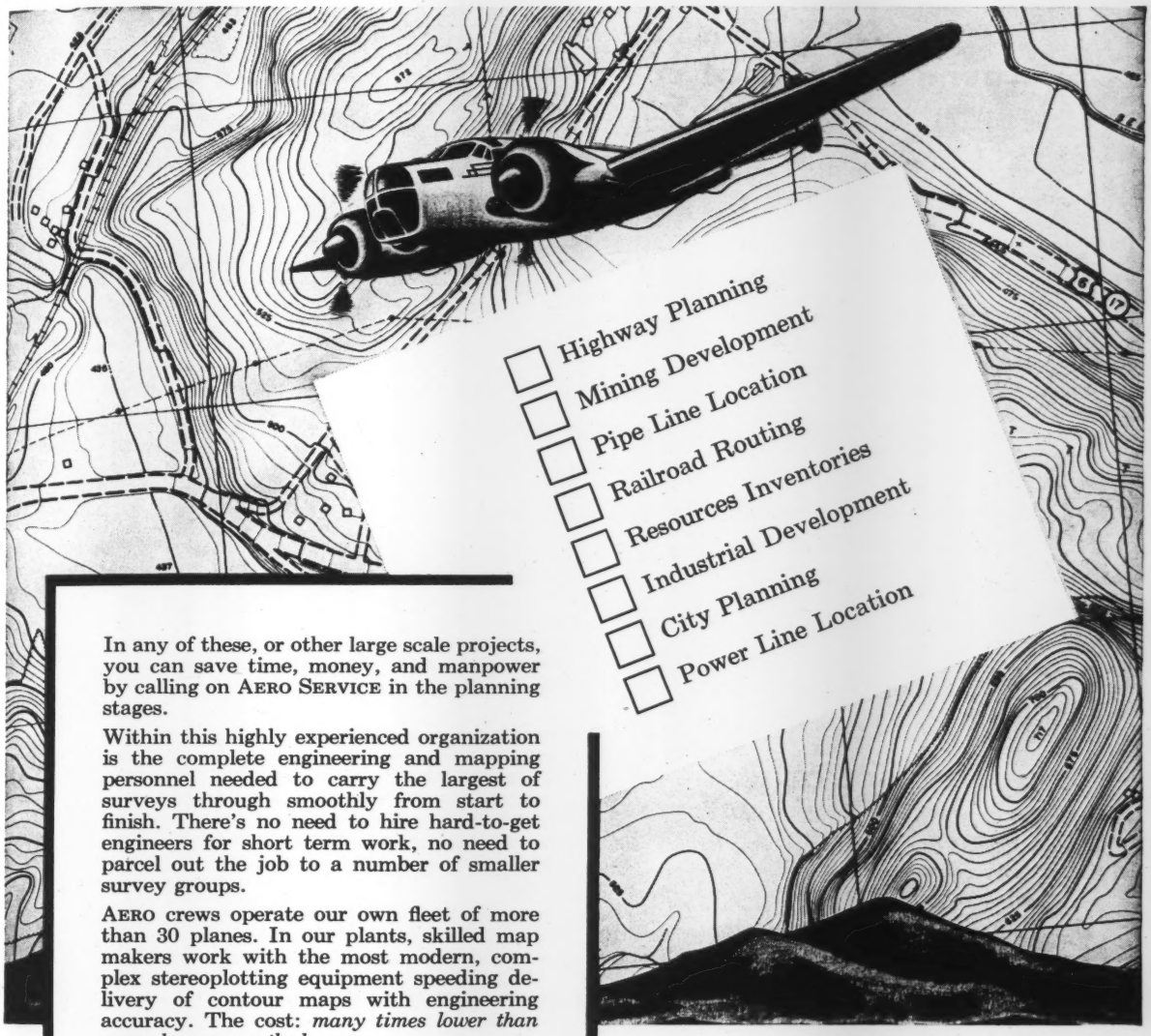

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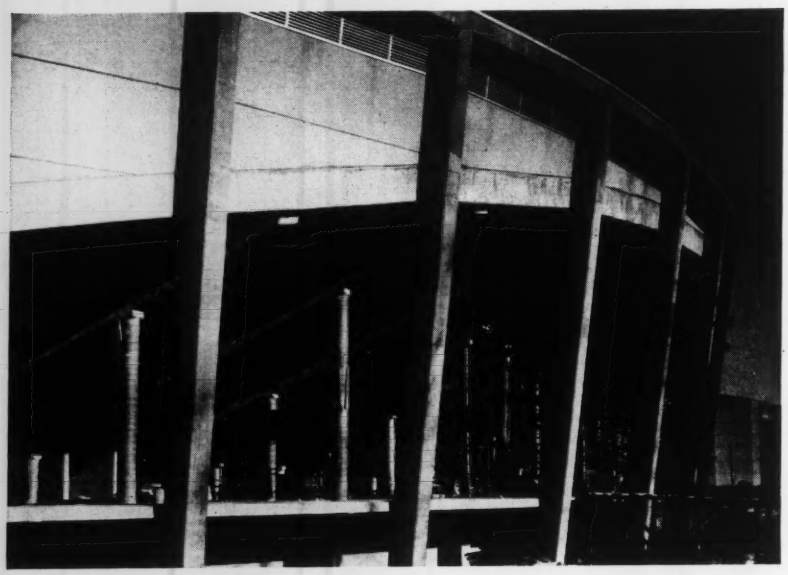

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(*Continued from page 94*)

Veterans Administration, Washington, D.C., died recently. A landscape designer, Mr. Mulvihill worked ten years as assistant to J. Nolen, town planner, at Cambridge, Mass., five years for the Harrisburg, Pa., Bureau of Municipalities, and for three years was technical-executive in the PWA Housing Division. During the war he was administrative assistant with the Corps of Engineers at Fort Monmouth, N.J. Mr. Mulvihill was a graduate of Pennsylvania State College.

John Leo Nagle (M. '41), age 67, for the past eight years director of the real estate division of the Public Buildings Service, General Service Administration, died in Washington on March 6. Mr. Nagle was design engineer for the Arlington Memorial Bridge Commission from 1922 to 1933, and then worked for the National Park Service on design and construction of PWA projects. During the war he was chief engineer for the Caribbean Engineer Division of the Corps of Engineers.

John James Nanry (M. '35), age 69, died at Pearl River, N.Y., on March 15. Resident engineer for the New York City Tunnel Authority since 1936, Mr. Nanry had worked on the Queens Midtown Tunnel and the Brooklyn Battery Tunnel. Earlier he had been with the Board of Water Supply and the Board of Transportation. He was a graduate of Cooper Union, class of 1909.

Luther Stevens Oakes (A.M. '05), age 77, since 1936 chairman of the Board of Directors of Winston Brothers Company, Minneapolis, Minn., and president of the company from 1921 to 1936, died on February 25. Mr. Oakes graduated from the Thayer School of Engineering, Dartmouth College, in 1900, and after work with the Northern Pacific Railway Company, joined Winston Brothers as superintendent in 1907.

Armando de Arruda Pereira (M. '28), age 65, president of the Federation of Industries of São Paulo State, Brazil, and former mayor of São Paulo, died on March 17. He was a graduate of New York University. Mr. Pereira spent most of his career with the Caramica São Caetano, a paving and roofing tile and brick company, São Paulo, which he joined in 1923 as industrial director and associate. In 1920 Mr. Pereira was elected a director of the Instituto de Engenharia de São Paulo. He was the first Latin American to be president of Rotary International.

Robert Kenneth Sawyer (A.M. '43), age 43, since 1952 managing director for the City of Philadelphia, died on February 11. A graduate of the University of Michigan, class of 1935, Mr. Sawyer taught at various universities before the war and then joined the Corps

(*Continued on page 98*)

1949 Within 48 hours after pouring this concrete, the section was open for all traffic.

1955 The same section after more than 5 years of relentless beating shows no evidence of wear.

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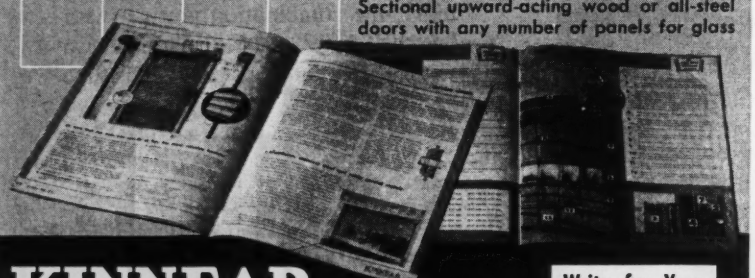

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(*Continued from page 96*)

of Engineers where he was promoted to the rank of lieutenant colonel. He started work in Philadelphia in 1946 as staff engineer with the Bureau of Municipal Research which he later directed. The following three years Mr. Sawyer was executive director of the Greater Philadelphia Movement.

Jay Randolph (M. '24), age 65, engineer and assistant plant manager for the Liberty Glass Co., Sapulpa, Okla., and a resident of Tulsa, died on February 12. In his early career Mr. Randolph was assistant city engineer for Colorado Springs and director of Public Service and city engineer for Boulder, Colo. In 1930 he became secretary and treasurer of R. J. Blackburn, Inc., in St. Louis, and later was president and general manager of the Sapulpa Union Railway in Tulsa.

William Lincoln Rockwell (M. '16), age 95, retired civil engineer of Houston, Tex., died on March 25. A civil engineering graduate of Cornell College, Mt. Vernon, Iowa, in 1890, Mr. Rockwell then became assistant engineer for the Columbia Valley Irrigation Company at Kennewick, Wash., and later was with other irrigation companies. From 1908 to 1919 he worked for the U.S. Department of Agriculture, in charge of irrigation in Texas. From 1926 to 1932, when he started a consulting practice in San Antonio, he was supervising engineer for the Maverick County Water Improvement, District 1, at Eagle Pass, Tex.

Joseph Wilson Smith (M. '24), age 75, retired chief engineer of the Erie Railroad Co., Cleveland, died in Newton, Conn., on December 24. Joining the railroad in 1904 following his graduation from Lafayette College, Mr. Smith was principal assistant engineer from 1929 to 1941 and chief engineer from 1941 until his retirement.

Frank McKee Stocking (A.M. '39), age 63, right-of-way engineer with the Washington State Highway Department at Olympia, died on March 29. Mr. Stocking was principal assistant to the Washington State field engineer from 1919 to 1937 and then became chief engineer for the Department of Public Lands for the State of Washington. During the war he was a lieutenant colonel in the Coast Artillery.

Clintin Draper Thurber (M. '11), retired captain of the Naval Corps of Civil Engineers, died in Meredith, N.H., on March 20. He was 77. A native of Attleboro, Mass., Captain Thurber joined the Navy Corps of Engineers as a civil engineer after graduation from Massachusetts Institute of Technology in 1900. During his thirty-four years of service he headed dry-dock construction at Pearl Harbor and was in charge of the construction of many installations at the Great Lakes Naval Training Center.

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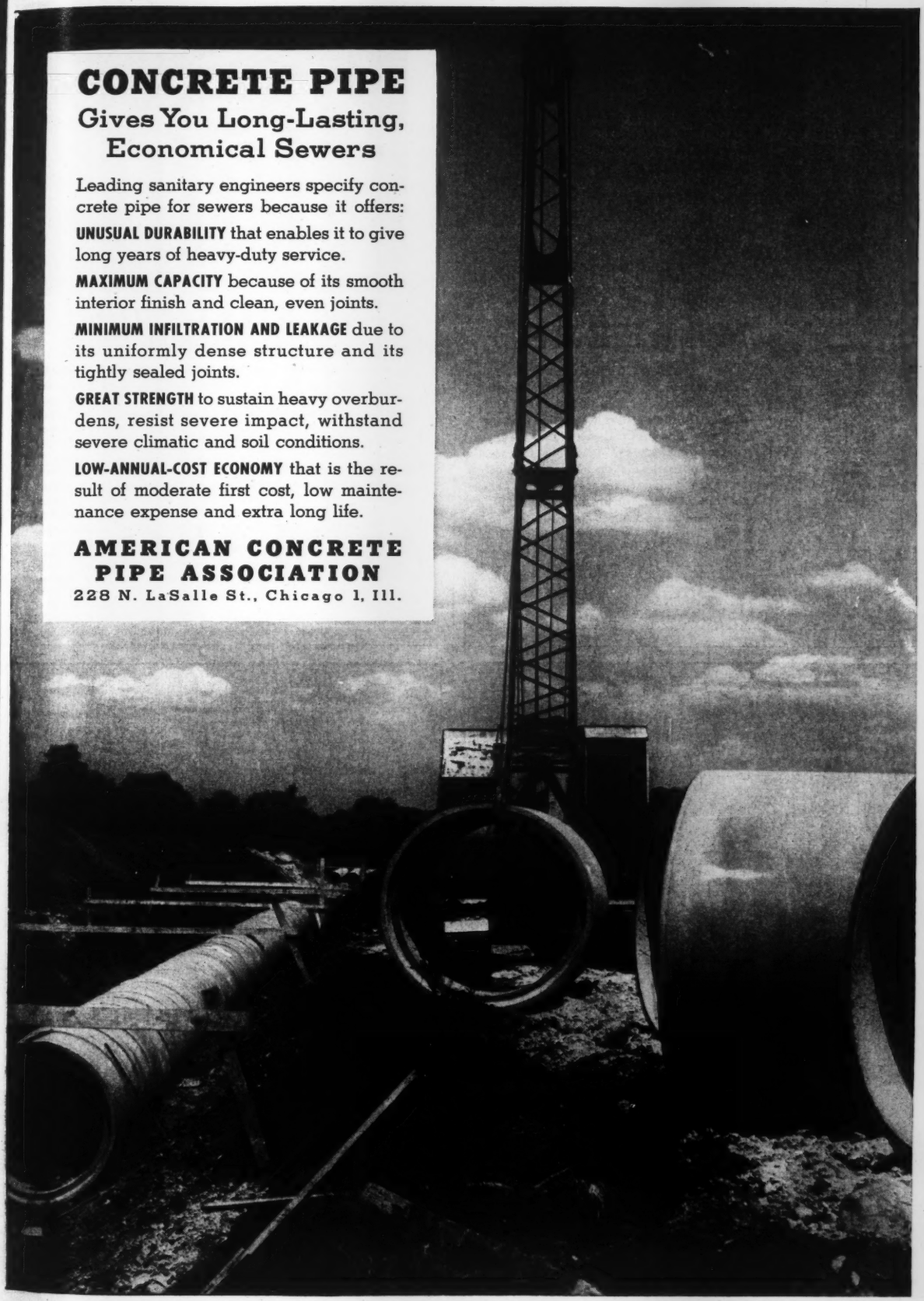

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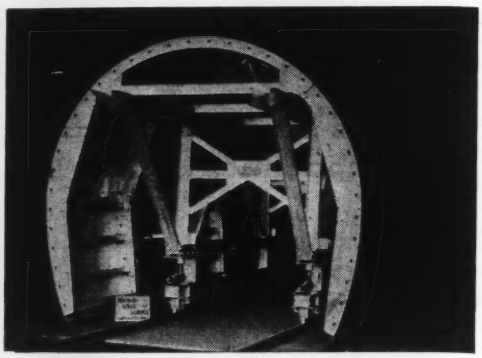

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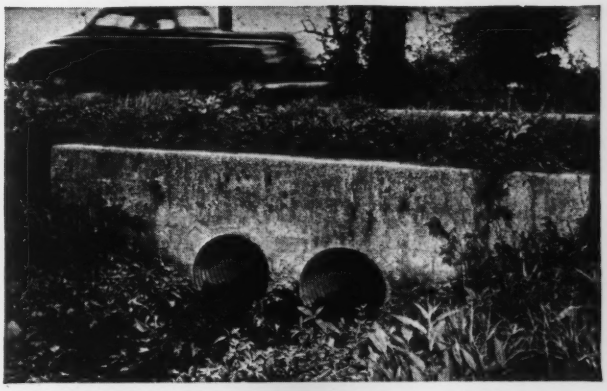
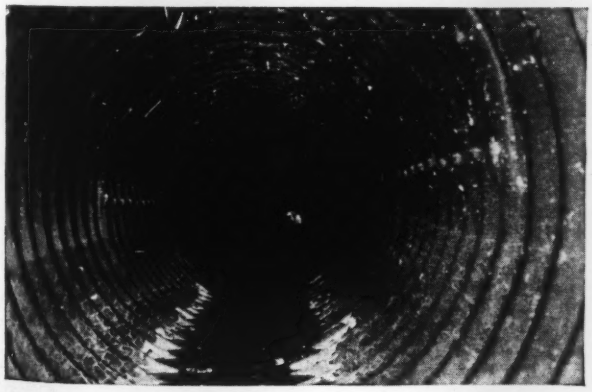


1. OHIO. Twin installation of Armco Pipe serves a busy road between Cincinnati and Dayton, Ohio.

2. NEW YORK. This 75" diameter Armco MULTI-PLATE Pipe still has good alignment.

3. MICHIGAN. Although this 84" diameter Armco Pipe supports part of the cracked headwall, it gives good service.

4. WEST VIRGINIA. To handle highly erosive drainage under Route 7, they installed this Armco PAVED-INVERT Pipe.



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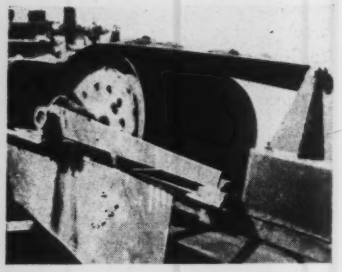

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Non-ASCE Meetings

American Institute of Electrical Engineers. Summer General Meeting at the New Ocean House, Swampscott, Mass., June 27–July 1. Details from Raymond C. Mayer & Associates, 36 W. 46th St., New York 36, N.Y.

American Society for Engineering Education. Sixty-third Annual Meeting at the Pennsylvania State University, State College, Pa., June 20–24. Headquarters and banquet, June 23, at the Hetzel Union Building. Information from Prof. K. L. Holderman, General Chairman, 103 Mechanical Engineering Building, Pennsylvania State University.

American Society for Testing Materials. Fifty-eighth Annual Meeting at the Chalfonte-Haddon Hall, Atlantic City, N.J., June 26–July 1. Annual dinner, June 29. Further information from F. F. Van Atta, Assistant Secretary, ASTM, 1916 Race Street, Philadelphia 3, Pa.

American Society of Mechanical Engineers. Semi-annual Meeting, with the theme, "The Engineer and the World of Science," at the Hotel Statler, Boston, Mass., June 19–24. Further information from F. M. Staszesky, Boston Edison Co., 182 Tremont St., Boston 12, Mass. National Applied Mechanics Conference at Rensselaer Polytechnic Institute, Troy, N.Y., June 16–18. Banquet, June 17. Further information from Dr. C. E. Work, Department of Mechanics, R.P.I., Troy, N.Y. International Conference on Combustion with Great Britain's Institution of Mechanical Engineers at Massachusetts Institute of Technology, Cambridge, Mass., June 15–17. Information from Dr. A. D. Blake, ASME, 29 W. 39th St., New York 18, N.Y.

American Society of Refrigerating Engineers. Forty-second Annual Meeting at the Hotel Schroeder, Milwaukee, Wis., June 12–15. Dinner dance, June 14. Details from ASRE, 234 5th Ave., New York 1, N.Y.

American Water Works Association. Seventy-fifth Annual Convention at the Conrad Hilton Hotel, Chicago, Ill., June 12–17. Details from H. E. Jordan, Secretary, AWWA, 521 5th Ave., New York, N.Y.

Fédération Internationale de la Précontrainte. Second International Congress at Amsterdam, Netherlands, August 29–September 2. Excursions to view prestressed and other construction. Further information from J. A. H. Hartmann, Secretary, Groningsestraat 15, The Hague, Netherlands.

Society of Automotive Engineers. Golden Anniversary Summer Meeting at the Chalfonte-Haddon Hall, Atlantic City, N.J., June 12–17. Further details from SAE, 29 W. 39th St., New York 18, N.Y.

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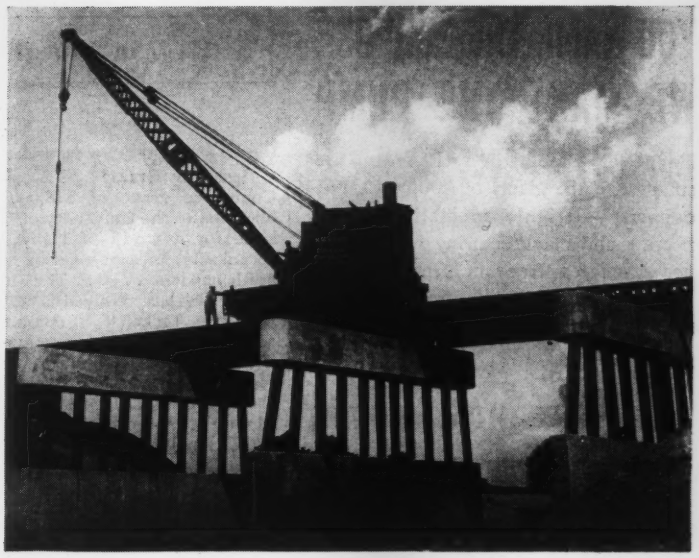

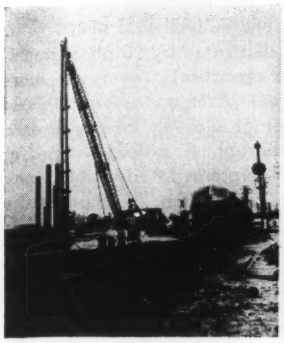

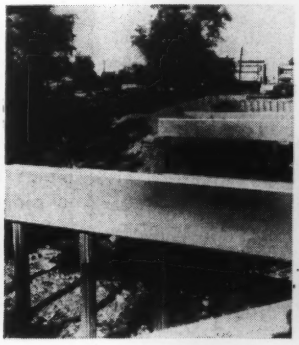

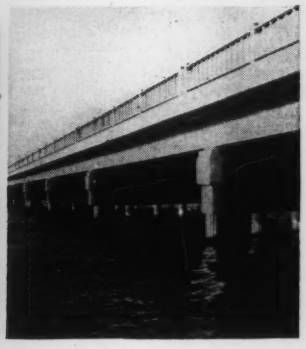

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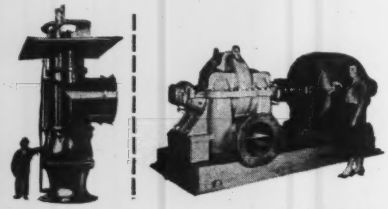

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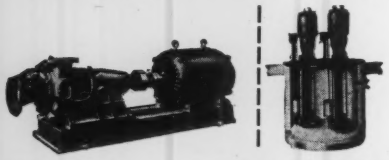

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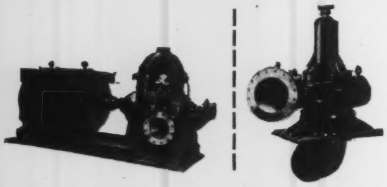

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New in Education

Research Grants. A Department of Commerce grant of $18,000 has been allocated to the University of New Hampshire for a study of highway safety—specifically an investigation of highway crash barriers. . . . . The University of Wisconsin has received a $250,000 gift from the Rockefeller Foundation for research on methods of trapping and utilizing the energy from sunlight . . . . . The National Science Foundation announces the award of 120 grants totaling about $1,600,000 for the support of basic research, conferences and studies, scientific information exchange, the scientific manpower register, and travel of American scientists to international scientific meetings.

Honors. Eight engineers received special Centennial Awards on May 13 from Michigan State College. The awards, presented at the Centennial symposium of the School of Engineering, were "For outstanding contributions to society, for achieving distinction in their endeavors, and for setting the highest standards of accomplishment." Society members honored were T. Frederick Burris, chief engineer, Chesapeake & Ohio Railway, Birmingham, Mich., and Verne L. Ketchum, chief engineer, Timber Structures, Inc., Portland, Oreg.

Scholarships and Fellowships. Dr. David B. Steinman, M. ASCE, New York City consulting engineer, has given $10,000 to the Kentucky Research Foundation and the University of Kentucky and a like amount to Newark College of Engineering to assist engineering students in completing their education . . . . . The New York architectural firm of Voorhees, Walker, Smith & Smith has established a faculty summer fellowship at Rensselaer Polytechnic Institute and the University of Virginia. The first recipients are, respectively, Prof. Alexis Yatsevitch of the R.P.I. Architecture Department and Prof. Roger C. Davis of Virginia University's School of Architecture. They will be in the firm's New York offices for ten weeks spending time in each of the departments . . . . . "Financing a College Education," a pamphlet with detailed analysis of methods of financing a college education with particular application to Rensselaer Polytechnic Institute, has been put out by R.P.I. The publication has been prepared to aid guidance counsellors in high schools and applicants for admission to engineering schools . . . . . The National Science Foundation has announced the award of 715 predoctoral graduate fellowships in the natural sciences for the academic year 1955–1956. The number of predoctoral fellowships given in engineering was 107 and, of the 70 postdoctoral fellowships awarded, 2 were for engineering.

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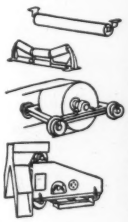

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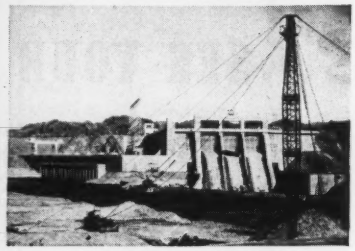

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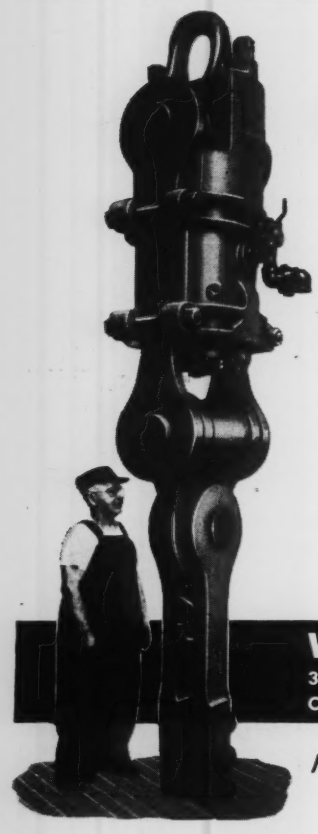

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New Publications

Soils Studies. Data derived from tests of full-sized piles and laboratory tests on model piles have been made available by the American Society for Testing Materials in two recent bulletins—*Symposium on Lateral Load Tests on Piles*, and a supplement to it, identified as ASTM Special Technical Publications Nos. 154 and 154A. The information presented will be helpful to engineers concerned with the design of dams, waterfront structures, buildings, tanks, and other structures resting on pile foundations. Copies of the symposium may be purchased for $1.50, and the Supplement (No. 154A) is $1. Requests should be sent to ASTM, 1916 Race Street, Philadelphia 3, Pa.

Plastics in Building. The uses of plastics in the building industry—discussed at the Building Research Institute's two-day conference on the subject last October—are reported in a 150-page illustrated volume announced by the Institute. Identified as Publication No. 337 of the National Research Council, the proceedings are priced at $5 a copy. Requests should be sent to the Building Research Institute, 2101 Constitution Avenue, Washington 25, D.C.

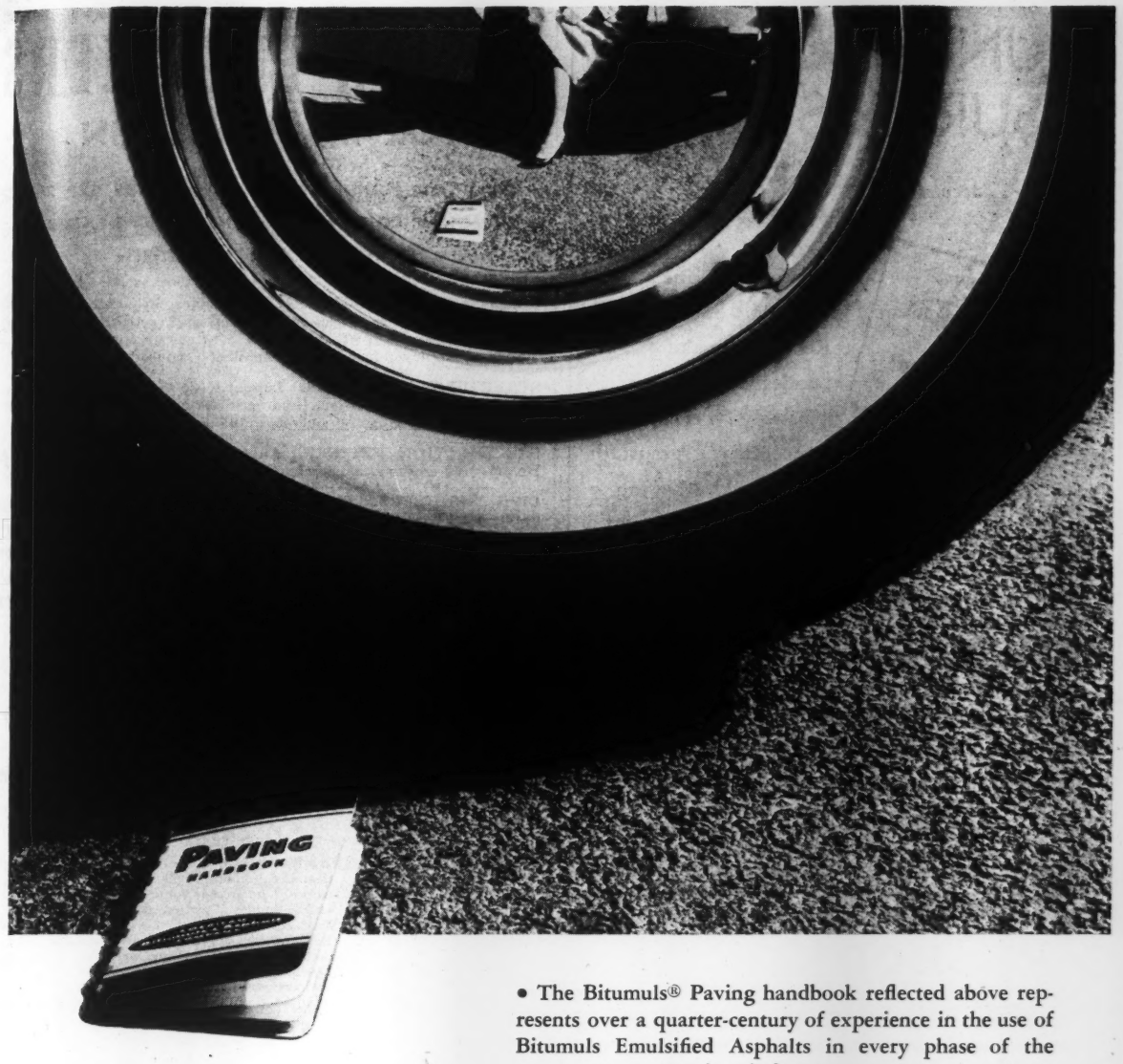
Engineering Economics. Availability of a new edition of *Engineering Economics and Practice*, including solutions to problems in New York State Professional Engineer Examinations, is announced by the authors, Max J. Steiberg and William Glendinning. Primarily intended to assist engineers in preparing for their Professional Engineer Examinations, the book will also serve as a handy reference for practicing engineers. Copies sell for $3 and may be obtained from Mr. Glendinning at 5123 Bell Boulevard, Bayside, N.Y.

Highway Construction. An evaluation of the potential of the American Road Builders' Association for executing the President's proposed $101 billion highway program is set forth in a recent brochure of the American Road Builders' Association entitled *The Highway Construction Industry in a Ten-Year National Highway Program.* The 56-page booklet includes capacity studies on Planning and Design, Materials and Supplies, Construction, and Machinery and Equipment. Copies, priced at $1 each, may be purchased from the ARBA, World Center Building, Washington 6, D.C.

Masonry Standards. A complete code of minimum requirements for masonry construction and for all types of masonry except reinforced masonry and thin veneers has been issued by the National Bureau of Standards as its Miscellaneous Publication 211, superseding Miscellaneous Publication 174. It was prepared by the Sectional Committee on Building Code Requirements and Good Practice Recommendations for Masonry (A 41) under the sponsorship of the Bureau. Copies, priced at 20 cents each, may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

Refuse Disposal. Sound refuse-disposal practice is discussed in the Proceedings of the tenth annual Local Government Conference held at the University of Pittsburgh last April. Sponsoring groups were the university's Graduate School of Public Health and Institute of Local Government and the Pennsylvania Department of Health. Inquiries should be addressed to the Graduate School of Public Health, University of Pittsburgh, Pittsburgh 13, Pa.

Saline Water Studies. To help member states concerned with problems of the desert, UNESCO has published a book entitled *The Utilization of Saline Water*, which reviews up-to-date research on the subject and shows what current techniques are proving successful. Priced at $1.75 a copy, the volume is available through UNESCO sales agents everywhere and in New York at the Columbia University Press (2960 Broadway) and the United Nations Bookshop.



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RECENT BOOKS

The Design of Cylindrical Shell Roofs

Though the treatment is mathematical, emphasis throughout is on the designer's concern with the use of derived equations in his calculations. The book by J. E. Gibson and D. W. Cooper includes a discussion of general theory, the complete design of a simple long shell, and consideration of various edge conditions—free edges, edge beams, and prestressed edge beams. There is a separate section on the use of matrices, and practical questions of reinforcement are treated. The final chapter deals with general shell theory and multi-shells. (D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N.Y., 1954. 186 pp. $8.50.)

Fluoridation as a Public Health Measure

The major emphasis in this monograph edited by James H. Shaw is on the effectiveness of fluoridation in reducing dental caries and on its validity as a public health procedure. It includes a review of the benefits of fluoridation, studies of results in a number of test areas, and an evaluation of vehicles other than water—salt, solid foods, tablets, etc. Separate chapters deal with engineering and chemical aspects, and with the determination of fluorides in water. References are listed after all chapters but one. (American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington 5, D.C., 1954. 232 pp., $4.50.)

Fluid Mechanics

An introductory textbook by R. C. Binder which aims to present a balanced, practical treatment of fundamentals and to keep physical concepts and quantitative relations in the foreground. Part I covers basic relations: fluid statics; geometry of motion; the relation between force, mass, and acceleration; internal friction; etc. Part II gives information on current practices and on applications of the basic material of Part I. Each chapter is followed by a list of selected references and numerous problems. (Prentice-Hall, Inc., 70 Fifth Avenue, New York, N.Y., 3rd edit., 1955. 388 pp., $7.65.)

Foundations of the Nonlinear Theory of Elasticity

An exposition by V. V. Novozhilov of the theory of elasticity without any assumptions restricting the magnitudes of elongations, displacements or angles of rotation, and an examination of the connection between stresses and strains in an isotropic elastic body. The theory as exponded is applied to the solution of a number of problems, including stability of elastic equilibrium; deformation of bodies having initial stresses; bending of plates and shells under deflections of the order of magnitude of the thickness; and deformation of elastic bodies which do not obey Hooke's law. The book has been translated from the 1948 Russian edition. (Graylock Press, Rochester, N.Y. 1953. 233 pp., $4.00.)

A History of Technology

Volume I: From Early Times to Fall of Ancient Empires

This is the first of five volumes which will record the history of how things have been done and made from the earliest times through the nineteenth century, with the object of showing how the complex technical knowledge of our civilization has come into being. A vast amount of information has been coordinated and presented in scholarly fashion by the wide range of authorities who contribute the separate chapters of the work. The present volume, covers man as hunter and as builder of settled societies, and treats fully the technology of the first civilizations of the Near East. Such subjects as water supply, use of metals, transport, writing, weights and measures, mathematics, and many others are discussed in their origins and early development. Over five hundred textual figures and a number of plates are included. The editors are Charles Singer, E. I. Holmyard and A. R. Hall. (Oxford University Press, 114 Fifth Avenue, New York 11, N.Y., 1954. 827 pp., $23.55.)

The Nation Looks at its Resources

A selection and condensation of reports and discussions of the Mid-Century Conference on Resources for the Future expressing a broad range of interests and viewpoints on the demand for natural resources, their supply and utilization. The contents of the volume are arranged by the sections into which the conference was divided: competing demands for the use of land; utilization and development of land resources; water resource problems; non-fuel minerals; energy resources; United States concern with world resources; problems in resources research; and patterns of cooperation among private and public groups. Appendexes give a list of registrants and indexes of subjects and speakers. (Resources for the Future, Inc., 1145 Nineteenth Street, Washington, D.C., 1954. 418 pp., $5.00.)

Statik der Bogen und Gewölbe

This treatise by W. Swida on the statics of arches and vaults presents the theory of the single arch and gives examples of calculations, taking into account the latest load allowances and design specifications (German standards). A separate folder contains 12 plates of analytical charts and structural details of bridges. (Verlag C. F. Müller, Karlsruhe 1954. Part I, 188 pp., Part II, 11 sheets in folder, DM. 22.00.)

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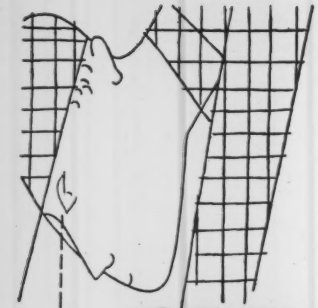

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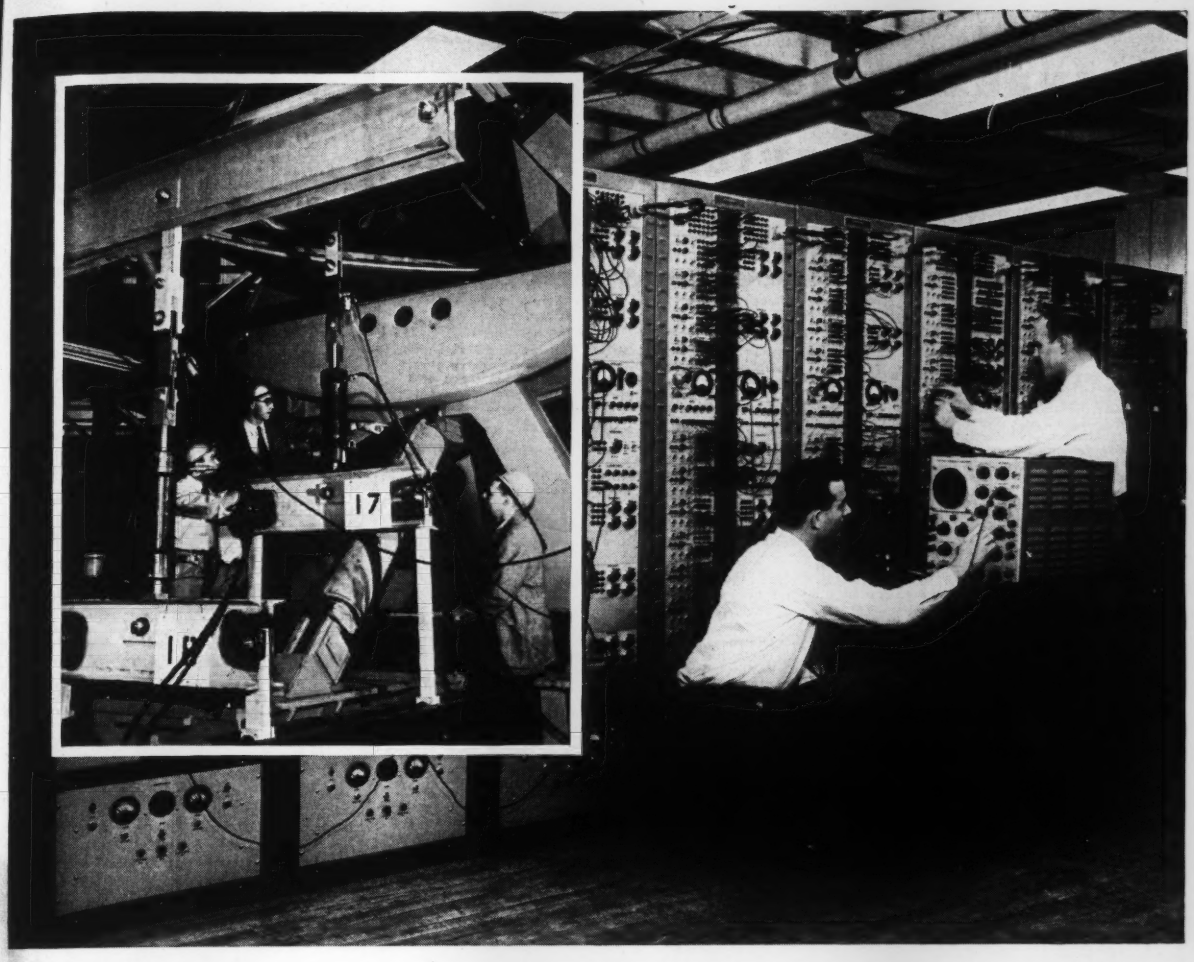

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This placement service is available to members of the Four Founder Societies. If placed as a result of these listings, the applicant agrees to pay a fee at rates listed by the service. These rates—established to maintain an efficient non-profit personnel service—are available upon request. The same rule for payment of fees applies to registrants who advertise in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York Office. Please enclose six cents in postage to cover cost of mailing and return of application. A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription rate of $3.50 per quarter or $12 per annum, payable in advance.

Men Available

SANITARY ENGINEER; J.M. ASCE; 33; married; M.C.E.; P.E. (New York); one year sewage treatment operation; one year research water coagulation; seven years' experience design, estimating, preparation of plans, specifications and reports for all types of sanitary engineering projects. Desires position with advancement potential. Will relocate. C-52.

HIGHWAY—SANITARY ENGINEER; J.M. ASCE; age 28; B. S. in structural engineering, M.S. in sanitary engineering expected in June; P.E. (Michigan). Over five years' experience in all phases of highway engineering; two years as survey chief—senior project engineer in highway surveys and construction. Civil engineering instructor. C-54.

DIRECTOR RESEARCH, ENGINEERING; 48; Ph.D. applied mechanics, Stanford; civil and mechanical engineering; registered; ten years direction of basic, product, materials and structural research and development; aircraft, machinery, metals, automotive fields. Coordinator for large aluminum processing plant construction, equipping, operation. Eight years in plant and industrial engineering. Administrative, personnel, sales training; excellent health. C-55.

ASSISTANT PROFESSOR; A.M. ASCE; 43; married; ten years' experience in teaching structures, surveying, mechanics, etc.; ten years' experience in structural design, surveying, and construction; licensed professional engineer and land surveyor; desires position as professor, associate professor or as design engineer with consulting firm. C-56.

Positions Available

SANITARY ENGINEER; 35–45; graduate; experienced in design and construction of water and sewage plants; to develop and analyze operating costs and make recommendations regarding cost control, recommend changes to improve operating efficiency, assist in preparation of plans for expansion of these utilities. Starting salary, $9,000 a year, plus or minus. Location, South. W-1303.

ENGINEERS; (*a*) Structural Designer; Civil Engineering graduate with experience on steel and concrete structures, storage tanks and foundations. Salary, $6,600–$8,400 a year. Location, Near East. (*c*) Specs Writer and Cost Estimator; with construction experience on buildings, pumping stations and equipment. Must be U. S. Citizen. Salary $6,000–$7,850 a year. Location, Near East. F-1356.

SPECIFICATIONS WRITER; 30–40; with seven to ten years' experience writing complete spec on heavy civil engineering, including paving, grading, drainage, for military operations, mostly airfields. Should have some knowledge of mechanical and electrical specs or work with Corps of Engineers. Salary, $6,760–$7,800 a year. Location, New York, N.Y. W-1357.

CONSTRUCTION MANAGER; Civil Engineer with at least ten years' experience supervising steam and hydroelectric power plants and general heavy construction. Salary, $14,000–$15,500 a year. Headquarters, New York, N.Y. W-1354.

CIVIL ENGINEER; 21–40; for a two year assignment in the development of a crude rubber plantation. Work consists of building roads, factories, hydroelectric plant and other facilities. Salary, $4,800–$5,700 a year, plus foreign service incentive, 40% of base pay; many other benefits. Housing and furniture supplied by company. Location, Liberia. F-1370.

TECHNICAL PUBLICATIONS ENGINEER; civil or mechanical; 30–45; with ten years' experience planning and execution of engineering research work. Evaluating experimental test and performance data. Knowledge of higher mathematics and physics. Will assist supervising engineer by analyzing research and field performance data, evaluating and organizing in a form suitable for product design manuals circulated throughout industry. Company is producer of integrated steel, tubular products. Salary, about $7,000 a year. Location, Pennsylvania. W-1382.

HYDRAULIC ENGINEER; civil graduate with at least fifteen years' design, field engineering and construction experience on irrigation, hydroelectric and general water resources projects. Salary, $9,950 a year plus extras. Location, India. F-1384.

CIVIL ENGINEER; to 40; graduate with experience in industrial plant design, layout and construction. Salary, $7,000–$7,500 a year. Location, South. W-1385(c).

JUNIOR CIVIL ENGINEER; with two-three years' experience, preferably in field on construction and/or surveying; for work in connection with design and operation hydro systems; also structural, foundations for steam and diesel plants. Some travel. Location, New York, N.Y. W-1408.

ASSISTANTSHIPS; in civil engineering department; 50% of time will be spent in graduate work and the other half in research project. It's possible to secure MS in two years. Formal course work is offered in the fields of Civil Engineering, Structural Engineering, Soil Mechanics or Applied Mechanics. Must be citizen. Location, New England. W-1414.

JUNIOR CIVIL OR ARCHITECTURAL ENGINEER; for training in technical service division of cement producer. Must be free to relocate. Location, New York City. Salary, $4,368 a year. W-1427(b).

CONSTRUCTION INSPECTORS; with at least ten years' experience, preferably on air field construction. (*a*) Concrete and Asphalt Paving (*b*) Heating, Ventilating and Power (*c*) Welding (*d*) Building Materials Laboratory. Salaries $9,600–$10,800 a year. Location, Labrador. W-1439.

DIRECTOR; evening school director, with M.S. in engineering. Some teaching experience covering evening courses in technical institute. Salary, $6,500 a year. Location, New York, N.Y. W-1450.

Civil and Structural Engineers

To design new oil-refineries and chemical plants. The work is basically a design of steel and reinforced concrete structures. And site-development engineering.

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Unusual engineering opportunities exist in our well established firm in connection with the design, construction supervision and inspection of a wide variety of engineering projects in both concrete and steel. Included are bridges, industrial buildings, advanced test facilities and other construction of an industrial nature, and various types of highway work.

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Consulting Engineers
915 Olive St. Louis 1, Mo.

INSTRUCTOR; for drawing, freshman engineering problems and mechanics. Branch immaterial. Position starts September 1955. Salary open. Location, West. W-1454.

SUPERINTENDENT, ASSISTANT SUPERINTENDENT, FIELD OFFICE MANAGER; for highway project. Personnel other than the field office manager should be familiar with rock work, inasmuch as this highway work will include extensive rock blasting and excavation. All men should speak Spanish well. Location, Central America. F-1458.

OFFICE ENGINEER; Civil Engineer; preferably in his 30's; some field construction experience. Will do a limited amount of quantity take-off; material purchasing; negotiations of contracts; coordination of work between field offices and main office and between architects and main office. Location, New York State. W-1459.

OFFICE ENGINEER; with at least ten years' industrial and general building construction experience with general contractor covering plan alterations, specification changes, subcontracting, scheduling, etc. Salary, $7,800 a year. Location, New York, N.Y. W-1462.

TEACHING PERSONNEL. (*b*) Associate Professor; Ph.D. in Civil Engineering; to teach undergraduate and graduate courses in structural design, intermediate structures, reinforced concrete and foundations. Salary, to $6,000 for a nine month year. Location, South. (*c*) Instructor to teach surveying, fluid mechanics and other undergraduate courses. M.S.C.E. or post-graduate experience required. Salary, to $4,500 for a nine-month year. Location, South. (*g*) Assistant Professor to teach statics, strength of materials and kinetics. MS degree in any accredited engineering curriculum required. Salary, $5,000 for a nine-month year. Location, South. W-1472.

SANITARY ENGINEER; civil graduate with at least five years' experience in the design of water supply and waste disposal facilities. Salary open. Permanent position. Location, New York, N.Y. W-1475.

ASSISTANT INSTRUCTOR BSCE; INSTRUCTOR OR ASSISTANT PROFESSOR; MS degree desired; to teach courses in sanitary engineering (water supply, sewerage, hydraulics, hydrology, public health, etc.). Some industrial experience desired as well as teaching experience. Salary, $3,120–$6,180 a year depending upon experience. Possibility for evening teaching with additional compensation. Location, northern New York. W-1485.

ENGINEERING PERSONNEL; for foreign assignments; 35–45; with at least five years' experience in their field. Government security clearance required. (*a*) Project Engineer; graduate Electrical; ME or Civil; to take full charge and responsibility for investigating and planning electric power plants, dams, tunnels, specs, estimates and reports. (*c*) Hydraulic engineer; graduate Civil; to take charge of hydraulic structures, dams, tunnels, canals, etc. (*f*) Civil Engineer; graduate; to take charge of civil and structural design section for steam and hydro power plants. Salaries, to 25% more than present salary, plus living allowance; living facilities for family available. Duration, eighteen monghts or longer. Location, European Continent. W-1489.

ENGINEERS; (*b*) Design Engineer; Civil graduate; with experience on air fields covering concrete and asphalt runways. (*c*) Soil Engineer; Civil graduate preferably with MS in soils mechanics, to supervise borings, testing and liaison engineering with field designers. Salaries, $9,000–$9,500 a year plus $5 per diem. Location, Western Europe. W-1498.

TOWNSHIP ENGINEER; Must be registered engineer and familiar with the construction and maintenance of roads. Location, Pennsylvania. W-1509.

DESIGNERS; (*a*) Designer; civil engineering graduate with at least five years' concrete experience, to design and lay out foundations for steel mill equipment. (*b*) Architectural Designer with at least five years' industrial building experience. Salaries, $6,600 a year. Location, New York, N.Y. W-1510.

DESIGNER; experienced in hydraulic and sanitary work to supplement existing consulting office capacity. Salary open. Location, Midwest. W-1522.

INSTRUCTOR; to teach hydraulics courses. The position may or may not include graduate courses in hydrology and hydraulic structures. Opportunity to work toward Ph.D. in fluid mechanics or applied mechanics. Salary open. Location, New York, N.Y. W-1526.

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EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Four-Wheel-Drive Tractor-Shovels

TWO FOUR-WHEEL-DRIVE MODELS IN THE LINE OF "PAYLOADER" TRACTOR-SHOVELS feature a one cubic yd heaped-capacity in the one and a one and one-half yd heaped-capacity in the second. In the design of these models is 40 degrees of bucket "breakout" at ground level rather than at a three or four foot "carry" position. To obtain maximum loads with minimum effort, a powerful "pry-out" action is accomplished by using breakout pads on the ground as a fulcrum for leverage. The opposing load forces are thus transferred to the ground through the pads during the "breakout" instead of to the axle, wheels, and hydraulic system of the machine. A combination of underslung boom-arm design and positioning provides driver visibility and safety. The need for safety guards or screens to protect the driver from the boom-arms has been eliminated. **The Frank G. Hough Co., CE 6-114, 938 Seventh St., Libertyville, Ill.**

Trailer Unit

DESIGNED FOR USE AS AN ENGINEERING FIELD OFFICE and portable tool storage shed is a four-wheel trailer unit, known as the DeKalb Contractor 14 and 16. Either in the 14 or 16 foot units the trailer features the following: seamless tubular steel frame; fireproof construction; arc-welded galvannealed exterior panels; double rear doors; heavy duty rub rails at floor level; ladder step in rear; diamond plate floor; heavy duty hardware and undercarriage; interior sides lined with corrugated slats and a full swing turn table. In the 14 foot unit the dimensions are: 193½ in. long, 89 in. wide, 78 in. high. Those of the 16 foot unit are: 217½ in. long, 89 in. wide, 78 in. high. **DeKalb Commerical Body Corporation, Ce 6-114, W. Garden St., DeKalb, Ill.**

Optical Plummet Transit

THE OPTICAL PLUMMET PRINCIPLE HAS BEEN SUCCESSFULLY ADAPTED TO THE AMERICAN TRANSIT. The Gurley Model 57-FRH-20 Transit provides advantages to be gained from optical-reading theodolites. The time-saving version of this transit also features a shifting center which permits movement of the transit in two directions at right angles to each other, with little disturbance to the level of the plate. The optical plummet is, therefore, operative almost continuously during centering. Essentially, the optical plummet is a telescope through the optical center of the transit, pointing vertically when the transit plate is level. The reticle in the telescope consists of three concentric circles with lines at right angles leading to the center circle, which is just large enough to match the stake tack of the station point at the ordinary set-up height. To permit ease of observation, the plummet telescope is turned at right angles by means of a prism, so that the observer actually looks through the telescope horizontally. **W. & L. E. Gurley, Engineering Instrument Division, CE 6-114, Bulletin OP-57, Troy, N.Y.**

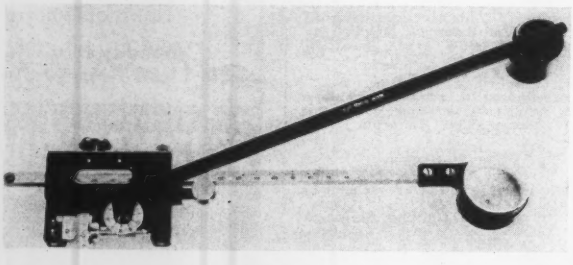
Model 57-FRH-20

Coatings and Linings

A LINE OF CHEMICAL RESISTANT COATINGS AND LININGS FOR PLANT MAINTENANCE, called Neocor C-10 and Neocor HD series, has been announced. Both series neoprene based are effective protection against a great many corrosive reagents as well as over a wide temperature range. Both series cure at room temperature. Neocor C-10 is a one package spray or brush coating applicable to any type of surface and is resistant to chemical spills, fumes and drips with a temperature range of −20 F to −275 F. Brushed on, coats of Neocor C-10 give a dry film thickness of 4–5 mils per coat. Neocor HD is a two package, curing, chemical resistant lining designed for emersion service over a wide temperature range. Neocor HD may be brushed or sprayed and, when cured at room temperature, is equal to most baked linings. It has an effective temperature range from −65 F to 300 F. Brush or spray applications have been accomplished to give a film thickness of 20–30 coats of ordinary coatings. **Corrosion Control Company, Inc., CE 6-114, 516 Fifth Ave., New York 36, N.Y.**

Copper Drainage Tube

ARCHITECTS, ENGINEERS, BUILDERS, CONTRACTORS, plumbers and building officials will be interested to know of the copper tube series announced by Mr. T. E. Veltfort, Manager of the Copper & Brass Research Association. To be known as Copper Drainage Tube, the product is expected to furnish the ideal material for use in soil, waste and vent lines in modern plumbing systems. Following a comprehensive investigation, the tube was scientifically developed specifically for sanitary drainage service. It will assure permanent installation because of the corrosion resistant properties of copper. **Copper & Brass Research Assoc. CE 6-114, 420 Lexington Ave., New York 17, N.Y.**



Planimeter

THIS OTT PLANIMETER FOR THE ACCURATE EVALUATION OF AREAS ON MAPS, drawings and charts is one of a variety of surveying and drafting instruments. For details on other types of precision planimeters, write to **Geo-Optic Co., CE 6-114, 170 Broadway, New York 38, N.Y.**

The Tree King

MASS PRODUCTION METHODS ARE BEING EMPLOYED IN the manufacture of articulated aerial boom devices at the request of industrial and utility operating executives intent upon securing an efficient low-cost aerial device. The result of this mass production is the Tree King, the latest Sky-Worker. Radical design changes provide a higher degree of maneuverability, greater height and longer reach than earlier models. The lower boom, moving through an overhead arc of 135°, 45° past vertical, results in a material reduction of operating time in reaching areas above, between and behind utility lines. Mounted on a conventional truck chassis, the unit enables a crewman at the controls to place himself at a comfortable working height of 45 ft from the ground. Horizontal working reach from the turret is 32 ft with a working load of 300 lbs. A completely equipped working "package" is available, consisting of a Tree King, truck, platform body with tool compartment, air compressor, pneumatic pruning tools, cab guard and compressor guard. **Maxwell Equipment Co., CE 6-115, Ford Street, Milford, Connecticut.**

Latest Sky-Worker

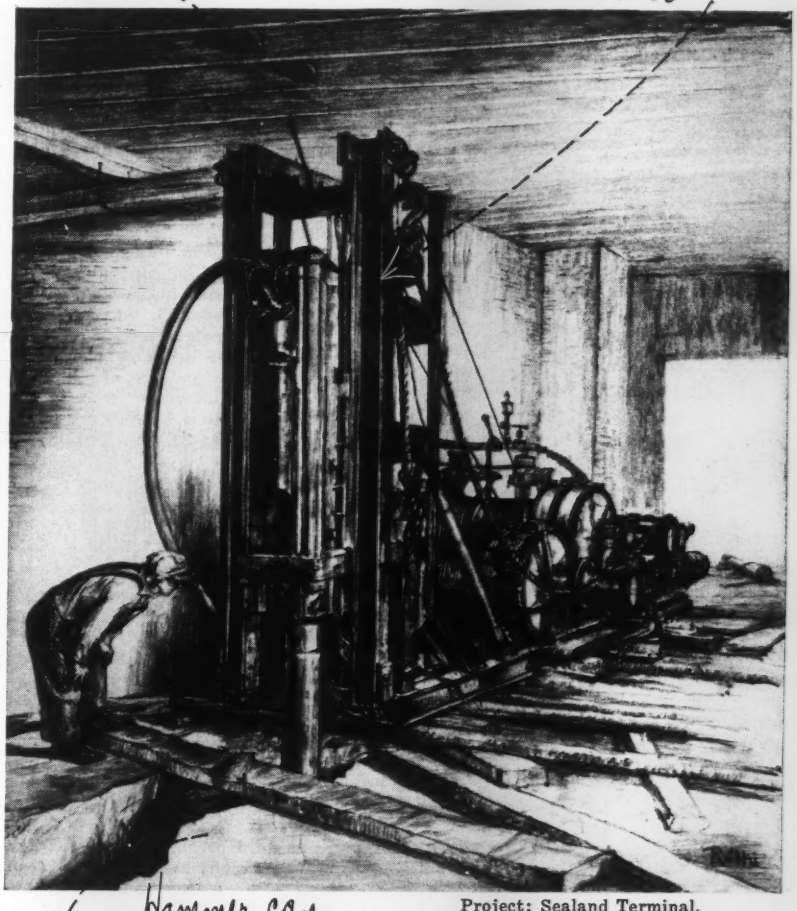
Road Measuring Instrument

ANOTHER IMPORT, THIS ONE FROM ENGLAND, MEASURES NOT ONLY ROADS, but all types and conditions of terrain accurately and efficiently. It is a measuring wheel called the "Trumeter." The wheel is not of the pneumatic type, which is dependent upon constant air-pressure for accurate measuring, but has a synthetic oil-resisting rubber covering ground to exact diameter. Other features of the "Trumeter" which facilitate accurate measuring are a scraper mounted at the rear to prevent obstructions and an arrow on the wheel to indicate the "starting position." **Trumeter Co. Ltd., CE 6-115, 265 Broadway, New York 1, N.Y.**

ANOTHER PROBLEM SOLVED BY SPENCER, WHITE & PRENTIS

Indoor Rig is of our design

Leads tilt back without removing hammer



Hammer can be hoisted above leads

Project: Sealand Terminal, Stein-Davies Corp., Brooklyn, N. Y.

SPECIAL RIG DRIVES PILES INSIDE A BUILDING

Even though headroom was only 16 ft., this special rig made it no great problem to drive the necessary pipe piles to bedrock. (This rig has driven such piles, in sections, to depths as great as 90 ft.)

It is one of many types of special-purpose equipment which Spencer, White & Prentis has developed. Tilting feature permits easy moving of the all-steel machine, even when headroom is reduced to as little as 6½ ft.

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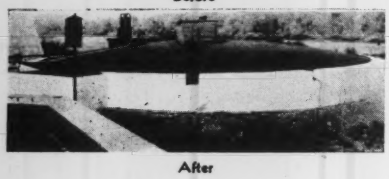
"GUNITE"

FOR REPAIRS TO SEWAGE DISPOSAL PLANT

Before



After

The existing concrete on this sewage disposal plant in western New York had deteriorated to an alarming extent and necessitated the rebuilding of practically the entire plant above ground. The pictures above are evidence that "Gunite" repair is not only practical but that it resulted in complete restoration of the plant.

On job after job, "Gunite" proves its worth. Our engineers will inspect your facilities and make recommendations for repairs without obligation on your part.

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EQUIPMENT MATERIALS and METHODS

(continued)

Portable Dredges

THE FIRST TWO NEWLY-DESIGNED PORTABLE "GENERAL PURPOSE" DREDGES OF A SOUTHERN IRON WORKS COMPANY have been shipped to Florida and to the British West Indies. They are used for deepening river, bay or harbor channels and for irrigation projects and dam building. The dredges can be shipped dismantled on a truck, freight car or in a cargo hold in an unusually small area and then reassembled "on the job," ready for action within twelve hours. For their comparatively small size, the dredges are nevertheless powerful. Because of this and their extreme portability and ease of assembly, they will be of much use in areas not accessible to larger equipment. **Georgia Iron Works Company, CE 6-116, 12th St., Augusta, Ga.**

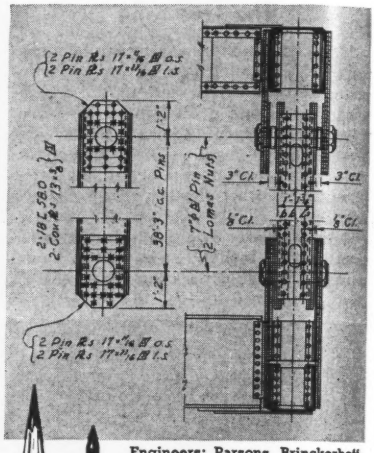
Steel Floor Armor

BELIEVED TO CREATE A MOST DURABLE FLOOR FOR ABNORMAL WEAR AND ROUGH USAGE is Hexteel safety floor armor that has less weight per sq ft and a greater exposed steel surface. The $^3/_8$ in. x 16 gage (.065) Hexteel has been developed to meet the increasing demand for a type of steel floor armor which can be used for resurfacing existing concrete or wood floors. The exposed steel surface armor is 18.15 sq in. per sq ft, and the weight of the Hexteel is 1.7 pounds per sq ft. The appeal of the Hexteel, in addition to its safety and economy factors, is that it can be used as a steel armor in new concrete floor installation, or in conjunction with a mastic fill on existing concrete or on existing or new wood floors. When installed, it forms a continuous steel floor armor which eliminates cracking, swelling, warping and shrinking. **Klemp Metal Grating Corp., CE 6-116, 6603 South Melvina Avenue, Chicago 38, Ill.**

Surfacing Machine

TO COMBAT HAZARDOUS DRIVING ON EXISTING OPEN STEEL GRID BRIDGE FLOORS, a "Safe-Grip" Surfacing Machine has been developed. This surfacing machine cuts small grooves in the top surface of existing open grid bridge flooring, and provides an effective non-skid surface which is particularly necessary in wet weather. Self-propelled, the machine allows highway engineers to maintain one-way traffic while it is in use. **Reliance Steel Products Company, CE 6-116, Walnut St., McKeesport, Pa.**

a vital detail



Engineers: Parsons, Brinckerhoff, Hall & Macdonald

This detail of a truss hanger joint for the Sunshine Skyway across Tampa Bay at St. Petersburg, Florida, permits the span to absorb deformations caused by temperature changes, variations in weight of traffic and other causes—a detail vital to the success of the project.

Another detail which top-flight engineers consider vital is the selection of proper tools—that's why so many use the Mars-Lumograph. They rate Mars-Lumograph imported drawing pencils and leads perfect for every step of the job, whether detailing or making working drawings. Get imported Mars-Lumograph pencils or Mars-Technico push-button lead holder and drawing leads. You will be glad you did.

The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H — $1.50 per dozen — less in quantity. The 1001 Mars-Technico push-button lead holder — $1.50 each — less in quantity. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H — $1.20 per doz., less in quantity.

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EQUIPMENT MATERIALS and METHODS

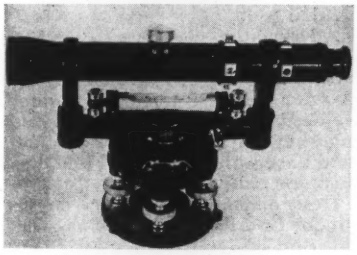
(continued)

Photogrammetric Instruments

COINCIDENT WITH THE WIDENING APPLICATION of aerial survey work in the construction industry, a new line of photogrammetric stereoscopes and Rangefinders is announced. These instruments are designed for all phases of the industry, from the bid to the last step in final construction. They are at present extensively employed by many agencies of the government for work on dams, highways, bridges, soil conservation, forestry, municipal planning, rivers and harbors. Both the observation and map plotting type of instruments are available as well as ground rangefinding equipment. **Meyer-Opticraft, Inc., CE 6-117, 39 W. 60th St., New York 23, N.Y.**

Imported Builders' Level

AN 11 IN. BUILDERS' LEVEL, WEIGHING ONLY 6½ LBS, HAS A 20-POWER TELESCOPE. The 3½ in. diameter horizontal has graduations to 30 mins. with double vernier reading to 5 mins. With the case the instrument weighs 12½ lbs. The imported level is precision made by ex-



With 20-Power Telescope

perienced optical craftsmen to American specifications and under American supervision. American parts and accessories can be interchanged. The fully guaranteed instrument is thoroughly checked before and after shipment. List price: $125. **Umeco Optical Division, CE 6-117 465 California Street, San Francisco 4, Calif.**

Wire Rope

A LINE OF WIRE ROPES WITH STEEL CORES HAS 15 PER CENT GREATER STRENGTH than the strongest grade marketed previously. One of the obstacles to rope of higher strength was a proportionate

(*Continued on page 118*)

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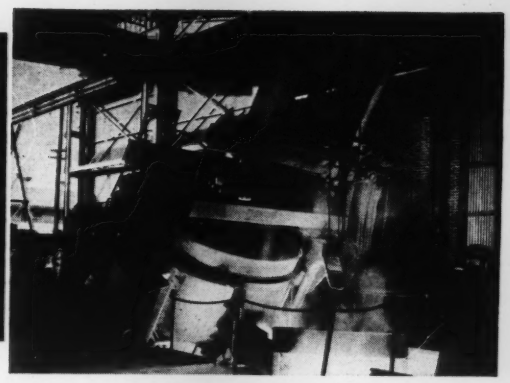

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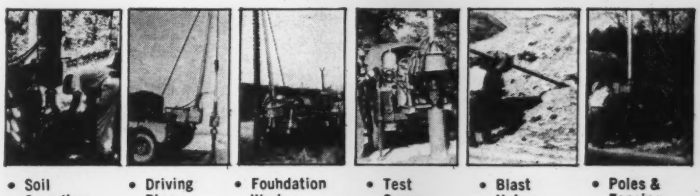

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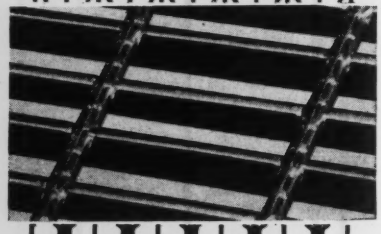

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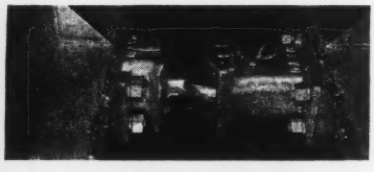
EQUIPMENT MATERIALS and METHODS

(continued)

decrease in other qualities as the strength went up. The new rope has higher resistance to wear from bending and abrasion. Manufactured primarily in preformed constructions, the rope will allow the handling of heavier loads for longer periods, as well as the drilling of deeper wells. The higher strength rope will be obtainable in rope sizes ranging from $1/4$ in. to $3\frac{1}{2}$ in. Industries that will benefit will be those which use a wire rope with independent wire rope core, such as construction, oil logging, mining, manufacturing and marine. **John A. Roebling's Sons Corp., CE 6-117,18, 640 South Broad St., Trenton 2, N. J.**

Automatic Coupler for Mine Cars

THE DEVELOPMENT OF A SAFE, QUICK-ACTING CAR COUPLER FOR NARROW GAUGE MINE CARS is announced. Entirely automatic, the coupler hooks on in seconds to eliminate all the hazards of hand coupling. To disengage, operator just lifts the eye,



Automatic Coupler Hooks

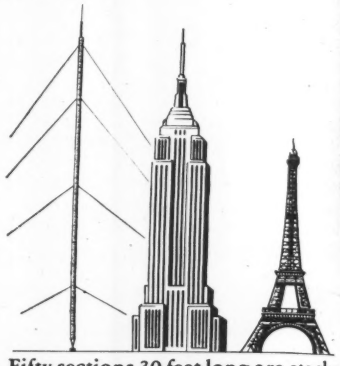
located safely out of the way on top of the female coupler head. Each coupling offers two in. slack to permit gradual starting of a heavy train and all parts are made of cast steel to provide trouble-free service. The automatic coupler may be attached to any existing mine car just by drilling four holes at each end. **Mayo Tunnel and Mine Equipment, CE 6-118, 650 High St., Lancaster, Pa.**

Midget Transit

A SERIES OF OPTICAL MIDGET TRANSITS HAS BEEN MADE AVAILABLE by the Aksania Werke AG of Berlin. The reading of both circles from one position with an accuracy of one minute estimation six seconds, the optical plummet (weather conditions) allows 100% faster work. A flashlight attachment enables night or underground work. This instrument weighs only $4\frac{1}{2}$ pounds, which makes it possible to carry the transit on the tripod. Its price is $595.00. Repairs are made in the United States. For a ten day trial or more information write to: **Geo-Optic Company, Inc., CE 6-118, 170 Broadway, New York 38, N. Y.**

WELDED DESIGN SPEEDS CONSTRUCTION OF WORLD'S TALLEST TOWER

A COMBINATION of efficient structural design and high speed manual shop welding is responsible for low cost of construction on this 660 ton, 1572-foot television tower. Built for Station KWTV, Oklahoma City, it is believed to be the tallest man-made structure on the face of the earth.



Fifty sections 30 feet long are stacked up to form the complete tower. Each section is straight sided with 12 foot face and three vertical legs forming the triangular section. The legs are tied together by horizontal girts of steel angles and diagonal bracing of steel rounds bolted to drilled gusset or wing plates which in turn are welded to leg members.

All structural members are machined and welded in fast down hand position with Lincoln Jetweld, iron powder electrodes using Lincoln AC welders. After galvanizing and painting, they are shipped knocked down, field assembled on the ground and then erected in the air.

Designers and fabricators, Dresser-Ideco Company, Columbus, Ohio. Erection sub-contractors, Mizell Construction Company, Ganado, Texas.

Welding wing plate to solid round tower leg with Lincoln Jetweld and Lincoln AC welders.

BENEFITS FROM WELDED DESIGN are available in Lincoln Studies in Structural Arc Welding. Available by request. Write

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LITERATURE AVAILABLE

THE VERTICAL PUMP—One of the most complete and authoritative reference books ever issued in the vertical turbine pump industry, "The Vertical Pump by Johnston," has just been published. This 392 page manual discusses pump selection for hot, volatile, viscous and corrosive fluids, applications, engineering formulas and data. The development of ground water resources, geology, drilling methods, well logging, construction, design and performance characteristics of vertical turbine, mixed flow and propeller pumps, and many other factors are analyzed. Leading world authorities have contributed specific papers to the book. Price $10.00 per copy. **Johnston Pump Company, CE 6-119, 3272 E. Foothill Blvd., Pasadena, Calif.**

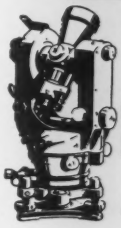
BRIDGING MACKINAC—The two peninsulas of Michigan are being linked by a new, four lane toll bridge which has an overall length of 26,444 feet. The booklet is the story of the construction methods for the five-mile long bridge. It shows that all concrete for the 34 foundation piers which carry 66,500-ton load of the superstructure is being placed by the Prepakt method. Mackinac Bridge will be the world's longest suspension bridge from anchorage to anchorage when completed in 1957. **The Prepakt Concrete Company, CE 6-119, Union Commerce Building, Cleveland 14, Ohio.**

HYDRAULIC CRANE—An eight page illustrated bulletin (AD-2253) describes an indoor-outdoor hydraulic crane. Included with specifications and performance data are diagrams on working ranges, manual boom extensions, minimum aisle widths for turns. Also described are attachments and special equipment. **Austin-Western Company, CE6-119, 601 Farnsworth Ave., Aurora, Ill.**

INDUSTRIAL STETHOSCOPE—A brochure is available describing a British electronic instrument which diagnoses mechanical troubles. Called the Auditec, it is a portable electronic detector, consisting of a metal probe and amplifier with controls for sensitivity and volume. It is provided with lightweight headphones. **John Ould U. S. A. Ltd., CE-6 119, 389 Fifth Ave., New York 16, N. Y.**

PAVING PRODUCTS—A catalog on Sealtight paving products covers asphalt expansion joints, corkfill expansion joints, fibre expansion joints, center strip, dummy joints, concrete curing compounds, subgrade paper, base plate, rubber asphalt joint seal, sewer joint compounds and road marking paints. This catalog not only contains all of the general information on each product, but also a standard specifications section. **W. R. Meadows, Inc., CE 6-119, Dept. PP, Elgin, Illinois.**

AT YOUR REQUEST IT'S HERE...



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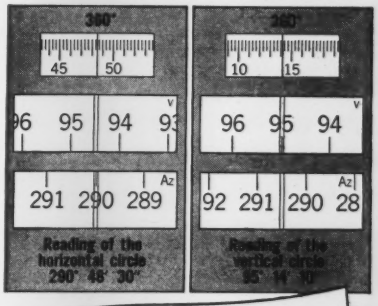
45 50
96 95 94
291 290 289
Reading of the horizontal circle 290° 48' 30"
10 15
96 95 94
92 291 290 28
Reading of the vertical circle 85° 14' 10"

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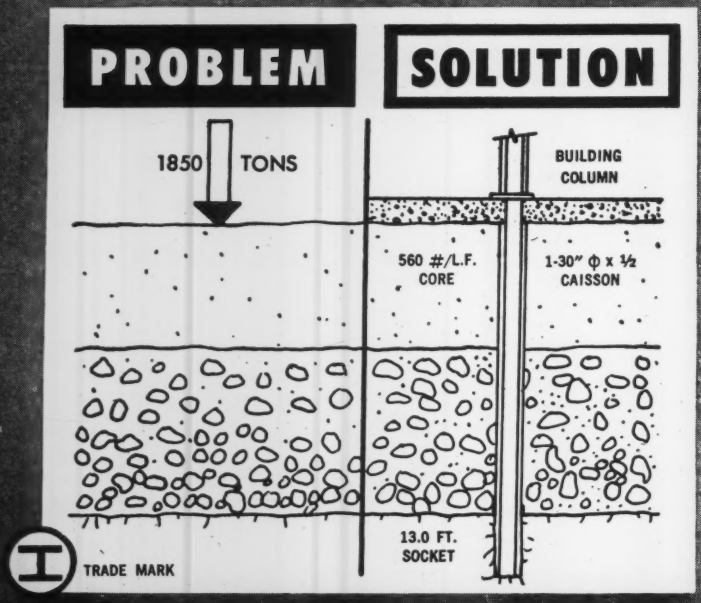

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LITERATURE AVAILABLE (Continued)

ROCK DRILLERS HANDBOOK—Publication of a "Drillers Handbook on Rock," reputed to be one of the most comprehensive drilling manuals ever compiled, is announced. The 68 page, pocket-size booklet discusses their hardness, texture, fracture and formation in detail. Readers are instructed how to judge the speeds with which various rocks can be drilled. A method by which the driller can establish a "point system" to figure drillability and drilling cost is also outlined. The price is $1.50. **Rock Drill Division, Davey Compressor Co., CE 6-120, Myers Ave., Kent, Ohio.**

IMPACT AND BRIDGE STRESSES—This is a committee report containing a description of the investigation of static and dynamic effects in a bridge consisting of beam spans supported on concrete filled Armco pipe pile piers. The tests were made on a railroad bridge with a special test train operating over a range of speeds from 5 to 58 mph. Armco is also offering a pocket-size drainage calculator for multi-plate arches and two sample templates for multi-plate pipe arches. **Armco Drainage & Metal Products, Inc., CE 6-120, Middletown, Ohio.**

MONEY-SAVER—"100 Ways to Save a Buck," a handy booklet for cost-conscious construction contractors, has been published by the National Safety Council. The booklet is an illustrated reprint of a talk by John A. Volpe, given at the 39th National Safety Congress. Mr. Volpe outlines the accident prevention program of his company and shows the many ways in which safety pays off in dollars saved. He includes a brief 10-point construction safety program for contractors. **The National Safety Council, CE 6-120, 425 N. Michigan Ave., Chicago 11, Ill.**

STEAM GENERATOR FOR PILE-DRIVING SERVICE—A steam generator built expressly for pile-driving service is described in a new bulletin just released. The bulletin includes complete specifications and overall dimensions as well as containing an explanation of the design and its distinctive features. A sectional drawing graphically shows the forced recirculation water system which is a prime factor in making the unit particularly efficient, and the system is fully explained in the bulletin. Another feature of special interest in the bulletin is the center spread which is arranged in "catechism" form to concisely answer questions concerning the unit. It also includes job illustrations showing how contractors have set up the unit with various convenient mountings. Copies can be obtained by writing for Bulletin #63. **McKiernan-Terry Corp., Dept. 3, CE 6-120, 15 Park Row, New York 38, N. Y.**

TIDE GATES

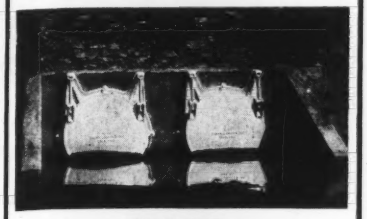

Fig. B-124-D

Two 60" Type M Gates on Relief Culverts near Woodward Pumping Station, Plymouth, Pa.

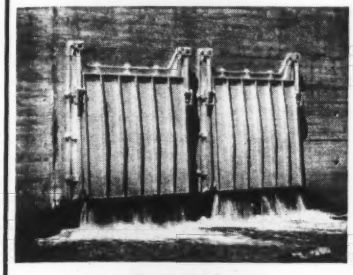

Fig. B-124-C

Two 72" x 72" Type M-M Gates on Toby Creek Outlet Works, Plymouth, Pa.

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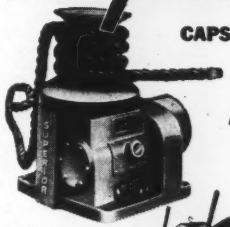

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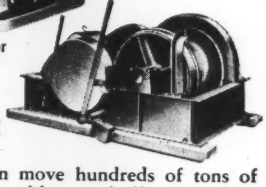

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LITERATURE AVAILABLE (Continued)

APPARATUS FOR ENGINEERING TESTS—The recent 104 page catalog contains descriptions and illustrations of over 1250 items of apparatus for engineering tests of soils, concrete, asphalt and construction materials. Included are suggested laboratory layouts with equipment lists for soils, concrete and asphalt laboratories. The 1955 Soiltest catalog has an extensive section devoted to soil mechanics apparatus from the basic sampling and preparation equipment to the actual testing machines for triaxial, unconfined compression, direct shear, California bearing ratio, consolidation and similar tests. **Soiltest Incorporated, CE 6-121, 4520 W. North Ave., Chicago 39, Ill.**

TENSION MATERIALS—A new catalog "Tensioning Materials for Prestressed Concrete" has been issued. The catalog gives detailed information and charts on characteristic properties of Roebling wire and strand, and includes descriptions and photographs of various construction jobs in which prestressing has been used. Featured in the new Roebling catalog are uncoated prestressed concrete strand for pretensioned bonded design, and anchor fittings for post-tension design. Tensioning applications are also described and illustrated by sectional drawings. **John A. Roebling's Sons Corp., CE 6-121, 640 South Broad St., Trenton, N. J.**

MEASURING AND CONTROL EQUIPMENT—To illustrate various types of control and measuring equipment, a four-page flyer has been prepared. General information is contained on both primary and secondary measuring devices. Included are short descriptions and characteristics of standard and elliptical Venturi tubes as well as parabolic flumes used as primary devices to actuate secondary indicating, recording and totalizing units. For Bulletin 050 write to the **Simplex Valve & Meter Company, C. E. 6-121, 68th and Upland Streets, Philadelphia 42, Pa.**

STEEL REINFORCED FLOORING—Following the introduction of a new Steel-Rock flooring, a two color bulletin has been published describing the many uses and advantages of this new type industrial floor. Claimed to outlive the plant itself, this new steel-reinforced flooring is especially designed for trucking aisles, loading docks and other similar areas subjected to materials handling equipment and severe abuse. The product may be used on interior or exterior surfaces of concrete or wood. **United Laboratories, Inc., CE 6-121, 16801 Euclid Ave., Cleveland 12, Ohio.**

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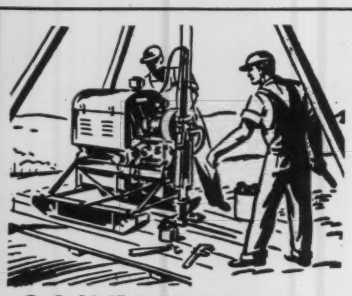

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From the MANUFACTURERS

NOW IN PEORIA: Caterpillar is parading almost two million dollars worth of earth-moving equipment before more than 500 dealers from the 48 states, Canada and the rest of the world. Visitors at the June Exposition are watching Cat machines perform on the 800-acre proving grounds . . . **ALUMINUM SEMISPHERE:** The 85 ft high dome of Le Tourneau in Longview, Texas, was built from the ground up. Sections were hoisted into the air as it was erected, like the "big top." Designed for civic events, it seats 12,000 people . . . **LAYNE AWARD TO MICHIGAN'S GOVERNOR:** G. Mennen Williams receives the 1955 Layne & Bowler tribute for his promotion of Michigan as the nation's "Water Wonderland" . . . **HONORS:** Henry Horton Armsby, Chief for Engineering Education of the U. S. Office of Education, receives the honorary degree of Doctor of Engineering at the commencement exercises of Newark College of Engineering. Donald C. Luce, president of the Public Service Electric and Gas Co., of New Jersey, also will be awarded the degree . . . **ACQUISITIONS:** The American Pulley Company of Philadelphia purchases the Safeway Industrial Equipment Corp. of Chicago, manufacturer of hydraulic lift trucks . . . Whiteman Manufacturing Co. of Los Angeles buys the Concrete Equipment Manufacturing Co., Inc. also of L. A. . . . **ELECTIONS:** Robert S. Stevenson becomes president of Allis-Chalmers Manufacturing Company . . . Elected as president of Wire Reinforcement Institute is Richard H. Frizzell of Wickwire Spencer Steel Division of the Colorado Fuel and Iron Corp. . . . Spencer, White & Prentis, Inc., chooses Joseph C. Weaver president of the foundation and underpinning company. Charles B. Spencer is now Board Chairman . . . Lincoln Electric appoints Norman J. Hoenie and Emmett Smith as chief engineers . . . Elected to the presidency of the Association of Engineering Colleges of New York State is Dr. Warren L. McCabe, administrative dean of the Polytechnic Institute of Brooklyn . . . A. Holmes Crimmins, treasurer of the Thomas Crimmins Construction Company, becomes president of The Moles, an association of tunneling and heavy-construction men . . . **APPOINTMENTS:** A. Carl Weber, Director of Research and Engineering for Laclede Steel Co., St. Louis, becomes Chairman of the Board of the Rail Steel Bar Association . . . Philadelphia Gear Works, Inc. appoints S. L. Crawshaw, gearing industry executive, Assistant to the President . . . Metal & Thermit Corporation names H. D. McLeese as General Sales Manager and Dr. J. E. Stareck as Director of Research . . . **CENTENNIAL:** Crane Co. celebrates 100 years of achievement. **MACHINE TOOL SHOW:** Chicago's International Amphitheatre is the place for the 1955 Machine Tool Show; Sept. 6–17 the date.

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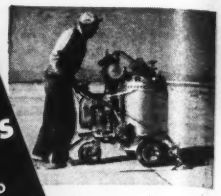
USE HOT POURED PARA-PLASTIC



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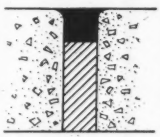

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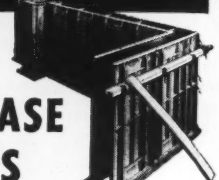

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PROCEEDINGS AVAILABLE

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679. **Analysis of Continuous Structures by Joint Rotation, by Charles T. G. Looney.** (ST) A method of analysis is described for the determination of the moments in a continuous structure due to an unbalanced moment of unity at each joint. The relative stiffnesses of the members meeting at a joint restrained at the far ends by adjacent members are determined so that the unbalanced moment of unity can be proportioned directly between the members. Carry-over moments to other members of the structure are also determined.

680. **Calculation of Pressure of Concrete on Forms, by R. Schjödt.** (ST) A formula for computing the pressure of concrete on forms is developed mathematically. The setting time, consistency and weight of the concrete, the smoothness, and the depth to which the working penetrates are considered. The material constants needed for the computation are examined and safe values indicated. Pressures obtained by using the formulas are compared with those in building practice and tests.

681. **Design of the Kingston Bridge over the Hudson River, by W. E. Joyce and C. H. Gronquist.** (ST) The design of a highway bridge over the Hudson River is described. The river spans are of the continuous-deck-truss type, with arched bottom chord. There are two continuous structures of 500-ft 800-ft 500-ft spans, joined by a double 500-ft span continuous truss and flanked on each end by a 300-ft span simple truss. Plate-girder viaducts 2563 ft long form the approaches to the truss spans.

682. **Discussion of Proceedings—Separates 451, 469, 539, 542, 560.** (ST)

683. **Bending in Annular Sections, by Adolphe A. Marrone.** (ST) The distribution of stresses on an annular section under an eccentric load is derived by use of the properties of circular arcs, assuming that the thickness of the annulus is small compared to the radius. The resulting formulas are extended to reinforced concrete sections subjected to bending only or to loads with any degree of eccentricity. Charts are presented, together with correction curves for thicker sections.

684. **Economy and Safety of Different Types of Concrete Dams, by August E. Komendant.** (ST) The design and construction methods currently used for dams fall far short of obtainable economy and safety because of the complexity of the problems involved in space structures. To avoid these complexities the thickness of dams is generally increased, thus sacrificing economy to obtain erroneous safety. The possible extreme stresses in dams computed by shell theory are presented, as is a comparison of the economy and safety of various dams. It is shown that Noetzli's conception of dam design can be most practically realized in a leaf-spring type shell dam that has prestressed abutments and is constructed by use of sliding forms.

685. **Corrosion and Corrosion Research, by Thomas R. Camp.** (SA) The paper describes the elements of the corrosion cell; the single electrode potentials of the many possible half-cell reactions can be computed from thermodynamic constants and the composition of the water. Only those half-cell reactions which produce the greatest electromotive force can take place. The method of identification of the half-cell reactions is illustrated. The theory may be used in selecting water-treatment processes for corrosion control. The theory underlying the correct procedure for polarization tests is developed, and it is shown that all unknowns may be evaluated if the single electrode potentials are computed first.

686. **Photosynthesis in Sewage Treatment, by William J. Oswald and Harold B. Gotaas.** (SA) Laboratory and pilot plant investigations of sewage treatment in open ponds by photosynthetically produced oxygen have provided some basic principles which can be utilized for the design of the process as well as for predicting the operational performance of oxidation ponds. The paper formulates design criteria based on these principles. The chemical, biological, operational, and economic factors which affect the use of photosynthesis as a method for producing oxygen and reclaimable wastes are outlined.

687. **Sedimentation in Rectangular Basins, by Claes N. H. Fischerstrom.** (SA) This paper points to the dominating importance of good hydraulic properties of a sedimentation basin in avoiding disturbances, even if hydraulic and sedimentation efficiency do not coincide. Means of obtaining good distribution in sedimentation units, good inlets and outlets, and especially desirable properties of stability and turbulence in the basins are suggested. The sludge problem is discussed in relation to the quality of the sludge, and types of basins for different kinds of liquids and sediments are described.

688. **Sanitary Fill Practice in Los Angeles County, by John L. Partin.** (SA) This paper reviews the "cut and cover" method of rubbish disposal as it has been practiced in Los Angeles County over the past seven years. It suggests some basic considerations necessary for a more universal acceptance of the method by the general public.

689. **Discussion of Proceedings—Separates 387, 496, 547, 552, 590.** (SA)

690. **Stresses in Elastic Plates over Flexible Subgrades, by Eric Reissner.** (EM) Studies of the effect of flexible surface layers on the load-carrying capacity of surface layer and subgrade are described. Analysis is based on the representation of the subgrade by a system of springs or a heavy

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liquid. Simple approximate formulas are obtained for maximum tension stress in the surface layer and maximum deflection of surface layer for loads distributed uniformly in circular areas. A bound is established for the range of applicability of these formulas; this bound determines the range of usefulness of the surface layer.

691. Strain Measurement Errors in Materials of Low Modulus, by R. C. Dove. (EM) When conventional SR-4 gages are bonded to the surfaces of materials having a very low modulus of elasticity, the local stiffening effect of the gage may be of great importance. Not only is the recorded strain less than the value of strain which would exist without the gage, but the distribution of strain in the material near the gage is altered. Examples of these effects are presented. The design and operating characteristics of several bonded gages developed to reduce this localized stiffening are described.

692. Stability of Beam Columns Above the Elastic Limit, by Robert L. Ketter. (EM) In the paper the behavior of pin-ended, steel, wide-flange beam columns is described, and a virtual displacement method of solution to the inelastic instability problem is developed. The method is equally applicable to the solution of elastic or inelastic beam-column problems, but its greatest application seems to be in the inelastic field. Using the proposed method, the critical value of loading for members subjected to concentric, eccentric, and/or lateral loads can be determined in a fraction of the time required by other solutions.

693. Photoelastic Analysis of Stress in a Dam Containing a Large Gallery, by R. L. Sanks. (EM) Mathematical analysis of a large gravity dam has been made difficult by the presence of a large gallery housing the turbines. Preliminary studies of two-dimensional models by photoelasticity determined dead and live load stresses with excellent accuracy. The techniques used are presented in this paper.

694. Analysis for Sheet Pile Retaining Walls, by F. E. Richart, Jr. (EM) A method for analyzing sheet pile retaining walls is developed by considering the piling to be cut at the dredge line. The backfill loads are applied to the embedded part of the pile, which is treated as a beam on an elastic foundation. The results of the computations involved in analyzing component parts of the problem are given on graphs. From these, coefficients can be taken for use in determining moments or deflections along the pile. Examples are given to illustrate the effects of soil and pile stiffnesses.

695. Blast Resistant Building Frames, by Bruce G. Johnston and Archie Mathews. (EM) In the paper suggestions are made for practice that will reduce damage to industrial building frames if they are subjected to bombing attacks. The type of building considered is a one-story steel frame construction, containing heavy machinery or other durable contents not liable to serious damage as a result of high winds of tornado proportions. The nature of the structural effects of an atomic explosion is discussed with emphasis on the wind gust aspect of the blast wave. General factors favoring maximum plastic resistance of steel beams, columns, and details are considered. Observance of the rules of design will result in improved resistance to earthquake and other kinds of shock load. A design example is presented.

696. Model Tests, Analytical Computation and Observation of an Arch Dam, by M. Rocha, J. Laginha Serafim, A. F. da Silveira, and J. M. Ressurreição Neto. (PO) Studies of the 34-m (111.55 ft) high upstream cofferdam of Castelo do Bode dam are described. Stresses and displacements were measured on two models (plaster-diatomite and "alkathene"). The structure was measured during the filling of the reservoir. Computations using the "abridged trial load method" are presented. The values from the model tests agreed closely with those observed in the structure.

697. Selection of Installed Capacity at Hydroelectric Power Plants, by Lesher S. Wing and Robert H. Griffin. (PO) A synthesis of procedures generally used to determine installed capacity at hydroelectric plants is presented, and certain fundamental concepts are outlined. Four criteria for determining benefit-cost ratios are discussed. The hydro installation determined by combining a single hydro plant with steam support in the most economic manner to serve a homologous segment of the system load is illustrated, and the limitations of this method are discussed. The critical incremental load factor is defined. The determination of hydro installations by selecting the lowest-cost increments of hydro capacity and energy is illustrated and recommended. Other phases of power-system development are described.

698. Setting Water Quality Criteria in California, by Vinton W. Bacon and Charles A. Sweet. (SA) The program of water pollution control in California has two goals —to protect the quality of the water for present and future beneficial uses and to permit planned usage of these waters for waste disposal. The four-step process whereby water quality criteria are set and waste discharges are controlled is explained and illustrated. The relationship of criteria established by the pollution control boards and the proposed California Water Plan is also explained.

699. Discussion of Proceedings—Separates 308, 355, 517. (PO)

700. Permeability, Pore Pressure and Uplift in Gravity Dams, by Roy W. Carlson. (PO) Results are presented of studies on pore pressure in the bodies of concrete dams and the resulting uplift force. The low permeability of concrete indicates that equilibrium pore pressure should never develop in a service dam. The effect of air entrainment is to reduce the penetration of pore pressure into a dam. An approximate solution for the percentage area subject to uplift pressure is offered, in which the area is expressed in terms of known voids and the ratio of the elastic modulus of the solid constituents of the concrete to that of the composite concrete. In view of the low permeability, high intensity of pore pressure need never develop in the interior of a gravity dam if reasonable precautions are taken.

701. Discussion of Proceedings—Separates 306, 544, 558, 562. (ST)

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